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ABSTRACT

This document is a collection of newsletters containing information on mathematics education. The newsletters, produced by the ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, contain information concerning center activities. News about professional organizations and activities are also included. Research reviews and bibliographical listings of articles and research on topics in mathematics education are included. Topics include reviews of research on secondary and elementary mathematics education for 1971 and 1972, and lists of references on mathematics laboratories, individualized instruction, and metrication. The last issue in this group, Vol. 5, No. 4, was the last that will be printed. (JP)

# SMAC

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ED 095005

## Center Comments

This bulletin is the first **ERIC/SMAC** newsletter devoted to mathematics education. The **SMAC** Clearinghouse has been growing by leaps and bounds and now processes materials in science education, mathematics education, and environmental education. To keep abreast of this growth, separate newsletters are now being issued for each of these areas. Mathematics education and science education newsletters will be issued four times a year on a quarterly basis. Newsletters for environmental education will be issued eight times a year. If you are receiving a newsletter which is not in your area of interest, please send us this information so that we may correct our mailing lists. If your colleagues would like to be added to our mailing list, be sure they specify which newsletter(s) they wish to receive.

## Let's Get Acquainted

Mathematics education is a recent addition to the **ERIC** system. Therefore this newsletter issue is devoted to acquainting you with the operations and services of the mathematics section of the Science and Mathematics Information Analysis Center (**SMAC**). Future newsletters will contain information on instructional materials, educational programs, research grants, short research reviews and special bibliographies. We would appreciate your suggestions for future newsletters or receipt of announcements or other material that should be disseminated to the mathematics education community.

The mathematics education section of the **SMAC** Clearinghouse began formal operation in March 1970. In this first year we have received approximately 2,000 mathematics documents, of which 1,500 were judged appropriate to mathematics education and were processed. Materials in mathematics education submitted to **ERIC** before March 1970 were processed by several different clearinghouses, with the bulk of this material coming gradually to the Science Education Clearinghouse. Thus the mathematics education document base in the system, while incomplete, is nevertheless broader than our first year's efforts. We need the cooperation of everyone in the mathematics education community if we are to continue to build a more substantial base.

We enter our second year with a new Associate Director for Mathematics Education. Dr. Jon L. Higgins, who joined our staff last year from Stanford University, has been appointed associate director for the 1971-1972 year. Dr. F. Joe Crosswhite continues with the center as a faculty research associate. In addition, Dr. Marilyn Suydam also joins the center as a faculty research associate for 1971-1972. She will be on part-time leave from Pennsylvania State University during this year.

SE017 936

## CALL FOR RESEARCH PAPERS
## NCTM Annual Meeting

Research Reporting Sessions are again planned for the NCTM Annual Meeting in Chicago, Illinois (April 16-20, 1972). The sessions will be jointly sponsored by the Council and the AERA Special Interest Group in Mathematics Education. Sessions will be planned around the following broad research categories: (1) aspects of mathematics learning, (2) teacher education and evaluation, (3) mathematics instruction and instructional materials, (4) mathematics achievement and its correlates, (5) general research topics in mathematics education. The paper may be of any length but presentations will be limited to 12-15 minutes. A paper which has been published or presented to another national meeting should not be submitted.

A committee will be appointed to screen proposals and select papers for presentation. Although a research category should be indicated for each submitted paper, papers will be judged on quality and not upon appropriateness to any category. Approximately 20 papers will be selected for presentation.

### PROCEDURES FOR SUBMITTING PROPOSALS FOR PAPERS

Those wishing to present a paper must submit six copies of a proposal—typewritten, double spaced, and not to exceed 1000 words. The proposal should contain the following information in order:

A. The mailing address of the sender (in the upper right hand corner).
B. The appropriate category for the paper (in the upper left hand corner).
C. Names of the author(s) and institutional affiliation(s). It is assumed that the first listed author will make the presentation unless otherwise indicated.
D. Title of the paper.
E. A summary of the paper to be presented describing the purpose and significance of the research, the conceptual framework, the procedures, the analysis, the results, and the conclusions if appropriate.

With each proposal submitted, the sender should enclose two self-addressed postcards. One will be used to acknowledge receipt of the proposal and the other to notify the sender of the decision of the screening committee. Decisions upon each proposal will be made by February 12, 1972.

### WHERE TO SUBMIT PROPOSALS

The proposal should be submitted as soon as possible, but in all cases before December 31, 1971 to:

Jon L. Higgins, Associate Director
**ERIC** Information Analysis Center for
Science and Mathematics Education
1460 West Lane Avenue
Columbus, Ohio 43210

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J. Peter Maucher
Manager of Institutional Sales
OR
E. Brien Lewis
Manager of Client Services.
(Both are at the above mentioned EDRS address.)

All correspondence and orders for EDRS services should be sent to the permanent address given above.

## Publication Lists Educational Information Resources

Over 200 educational information resource centers are announced in the **Directory of Educational Information Resources** compiled by Judy Wanger of the Systems Development Corporation, Falls Church, Virginia. The 189-page hardback book is available from:

CCM Information Corporation
909 Third Avenue
New York, New York 10022.

This 1971 directory is a revised and updated edition of the **Directory of Educational Information Centers** (U.S. Government Printing Office, 1969). The scope has been broadened with respect to the levels and kinds of information centers identified.

# Collections Available from EDRS

Leasco, Information Products, Inc. (LIPCO) has released the price schedule for **ERIC** special collections and the **Research in Education** back collections available from **ERIC** Document Reproduction Service (EDRS). Prices were determined by an actual inventory count of microfiche in each collection and represent the quantity of microfiche in each collection and the unit price applicable. New prices are as follows:

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|---|---|---|---|
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| Pacesetters in Innovation, Fiscal Year 1966 | 1,185 | $.14 | $ 166.00 |
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| Manpower Research, Inventory for Fiscal Years 1966 & 67 | 653 | $.14 | $ 92.00 |
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3. Include number of copies (1, 2, 3, etc.) to be ordered in appropriate space. Use MF space for microfiche copies; use HC space for hard copy (Xerox). *Check RIE for availability of document in MF and HC.*
4. Include unit price from the rate schedule. (Refer to price schedule on back.) Prices published in RIE through April 1, 1971 are incorrect. Consult May 1971 and later issues for correct pricing.
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Columbus, Ohio 43210

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SMAC

# MATHEMATICS EDUCATION BULLETIN BOARD

### Oakland Mathematics Project

The Oakland County Mathematics Project has announced that arrangements have been made with McKay Press of Midland, Michigan to print and supply project materials. These materials are designed for 9th & 10th grade students in the 25th-55th percentile. Each booklet concentrates on a single topic. The materials have been carefully field tested and are now available in classroom quantity for purchase and use by any interested school system. For description of available booklets and prices, write the publisher.

### Individualized Mathematics Program

The Southwest Educational Development Laboratory has announced the availability of their Individualized Mathematics Program, Grades 2-6 for field testing in the 1971-1972 school year. Administrators interested in field testing this or other SEDL programs in their schools should contact the Director of Learning Systems Testing, Southwest Educational Development Laboratory, 800 Brazos Street, Austin, Texas 78701. An IPI Mathematics Program for Grade 1 is currently being tested in selected schools in the Austin area, but is not available for wider testing at this time.

# SMEAC

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## CENTER COMMENTS

SEIAC → SMAC → SMEAC

To keep pace with expanding responsibilities, we have again changed our name. The Center originally processed documents only in the area of science education and our maiden name was Science Education Information Analysis Center (SEIAC). When responsibility for processing documents in mathematics education was added, we became the Science and Mathematics Information Analysis Center (SMAC). In March, 1970 we were designated as the processing center for documents related to environmental education as well. We are now known as the Science, Mathematics, and Environmental Education Information Analysis Center (SMEAC).

We feel that those areas we now encompass form a natural union and are mutually supportive. If readers of this newsletter would like to receive the Science or Environmental Education Newsletters as well, they should return the coupon on page three.

## JOURNAL SPONSORSHIP TRANSFERRED

The sponsorship of the journal **Investigations in Mathematics Education** will be transferred from SMSG to the Center for Science and Mathematics Education at The Ohio State University, effective January 1972. The journal will be established as a quarterly publication available on a subscription basis through the Center. It will continue to abstract and analyze recent research reports in the field of mathematics education. These reviews will be coordinated with research announcements appearing in **Research in Education** through the cooperation of the ERIC Clearinghouse for Science, Mathematics, and Environmental Education. As a result, copies of many of the documents referred to in **Investigations in Mathematics Education** will be available to readers from the ERIC Document Reproduction Service.

For further information about **Investigations in Mathematics Education**, or for subscription details, write to:

Jon L. Higgins, Editor
Investigations in Mathematics Education
Center for Science and Mathematics Education
The Ohio State University
1945 North High Street
Columbus, Ohio 43210

## Teaching Resources For Low-Achieving Mathematics Classes

SMEAC announces a new publication, **Teaching Resources for Low-Achieving Mathematics Classes**, by Kenneth J. Travers, John W. LeDuc, and Garth E. Rudnitzki. This paper reviews teaching approaches and general resource materials for low achievers in both elementary and secondary mathematics classes. A survey of reported characteristics of low achievers is divided into two classes: (1) social and emotional problems, and (2) learning difficulties. Characteristics related to class 1 problems include: high rate of absence, goals for the immediate future only, low motivation, antisocial behavior, short interest span, and inability to see the practical use of mathematics. Characteristics related to class 2 problems include: a record of failure in mathematics, a fear of the subject, achievement scores at least two years below grade level, reading difficulties, inability to follow directions, tendency to leap to conclusions, and inability to generalize. Teaching approaches reported as being successful include the use of computational aids, manipulative devices, and laboratory techniques. Also reported is the development of individualized short-term curriculum units, emphasizing success and immediate reward. The two bibliographies included are: (1) a bibliography of general resource material, and (2) an annotated bibliography of articles which have appeared in "The Arithmetic Teacher" and "The Mathematics Teacher."

ED 053 980
EDRS Price MF-$0.65 HC-$3.29

## New Publications Availability

The Center for Science and Mathematics Education at the Ohio State University now reprints selected SMEAC publications. These are made available at a standard price of $1.25 for single copies or $1.00 for two or more copies of the same title. A list of available titles in mathematics education may be obtained by writing:

Jon L. Higgins
Center for Science and Mathematics Education
The Ohio State University
1945 North High Street
Columbus, Ohio 43210

SE 017 936

## Research Sessions At NCTM Annual Meeting

Fourteen research sections have been scheduled for the 1972 NCTM Annual Meeting in Chicago. Research sections are scheduled as follows:

**Monday, April 17:**

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|---|---|
| 10:30 a.m. - 12:00 noon. | Symposium on Mathematics Laboratories. Panel: William Fitzgerald, Jack Wilkinson, Donald Kerr, John LeBlanc, Alan Barson |
| 12:15 p.m. - 1:45 p.m. | Research Reporting Section: Mathematics Instruction and Instructional Materials |
| 2:15 p.m. - 3:15 p.m. | "Evaluations: A Sounder Basis for Action." Donald B. Sension |
| 3:45 p.m. - 5:15 p.m. | Symposium on Problem Solving. Panel: Jeremy Kilpatrick, James W. Wilson, Max Jerman, J. Phillip Smith, John F. Lucas |

**Tuesday, April 18:**

| | |
|---|---|
| 8:45 a.m. - 10:15 a.m. | Research Reporting Section: Aspects of Mathematics Learning |
| 10:45 a.m. - 11:45 a.m. | "Soviet Studies in the Psychology of Learning and Teaching Mathematics." Isaak Wirszup, Jeremy Kilpatrick |
| 12:15 p.m. - 1:45 p.m. | Research Reporting Section: General Research Topics in Mathematics Education |
| 2:00 p.m. - 3:30 p.m. | Symposium on Coordinating Research in Mathematics Education. Panel: Richard J. Shumway, Fred Weaver, Eugene Nichols, Joseph Payne, David C. Johnson |
| 4:00 p.m. - 5:00 p.m. | Research Review: Language Factors and Mathematics Learning. Lewis A. Aiken, Jr. |

**Wednesday, April 19:**

| | |
|---|---|
| 8:45 a.m. - 10:15 a.m. | Research Reporting Section: Mathematics Achievement and Its Correlates |
| 10:30 a.m. - 12:00 noon | Symposium on Individualizing Instruction. Panel: Thomas A. Romberg, Robert Davis, Harold Fletcher, James Walters, M. Vere DeVault |
| 12:15 p.m. - 1:45 p.m. | "Toward a Theory of Instruction." Ralph Heimer, Paul A. Klein, Gerald A. Paquette, John J. Hirschbuhl, Daiyo Sawada |
| 2:00 p.m. - 3:30 p.m. | Symposium on Research on Secondary School Mathematics. Panel: Marilyn N. Suydam, Len Pikaart, Jon L. Higgins |
| 3:45 p.m. - 5:15 p.m. | Research Reporting Section: Teacher Education and Evaluation |

## *Special Mathematics Education Sessions Scheduled For AERA Convention*

The Special Interest Group for Research in Mathematics Education is sponsoring four sessions at the 1972 AERA convention to be held in Chicago, April 4-7, 1972. These include:

Invited Address: "Problems and Prospects for Research in Human Mathematical Behavior," Robert B. Davis, Syracuse University.

Discussion-Critique Session: "Planning for Future Piaget Related Research," Charles Smock, Leslie P. Steffee, Thomas P. Carpenter, David C. Johnson, Martin L. Johnson, Richard Lesh, and Douglas T. Owens.

"Planning for a Mathematics Education Research Pre-Session," James W. Wilson, F. Joe Crosswhite, David C. Johnson, Jeremy Kilpatrick, Marilyn N. Suydam, and J. Fred Weaver.

Discussion-Critique Session: "The Epistemology of a Theory of Teaching Mathematics," Thomas J. Cooney, Kenneth B. Henderson, John A. Dossey, Martha Pascal Benjamin, Kenneth Retzer, Lowell Ensey, Jeremy Kilpatrick, and Richard Turner.

In addition to these sessions, SIG/RME will co-sponsor three paper presentation sessions on Mathematics Learning, a paper presentation session on Problem Solving in Mathematics, and a symposium entitled "The Seven Most Applicable Research Reports of 1971 on Mathematics Education, K-12."

Other research papers related to mathematics education will be presented as part of the regular programs for Division B and Division C.

## *Third Annual Interdisciplinary Meeting On Structural Learning March 31-April 1, 1972*

The Structural Learning and Mathematics Education (MERG) Groups at the University of Pennsylvania announce a two day meeting on interdisciplinary research on structural learning. All scientists and other interested persons are invited.

Theoretical and empirical research will be given equal emphasis. More particularly the meeting will emphasize contributions which deal with one or more of the following questions:

1. How can one characterize the knowledge structures which underlie behavior typically observed in disciplines such as mathematics and linguistics?
   How can one evaluate alternative characterizations?
2. How can one determine the knowledge given individuals have at their command?
3. What are the mechanisms by which existing knowledge is put to use and how are structures learned?
4. What are the instructional conditions which control the acquisition of structures?

If you would like further information about the meeting, write:

Dr. Joseph M. Scandura
Graduate School of Education
University of Pennsylvania
Philadelphia, Pennsylvania 19104

## Second International Congress On Mathematical Education

Organized by the International Commission for Mathematical Instruction of the International Mathematical Union, the Second Annual International Congress on Mathematical Education will be held in Exeter, England from August 29—September 2, 1972. The organization of the Congress includes discussion groups, invited addresses, and national presentations. Requests for registration forms and accommodation reservation forms should be addressed to:

The Honorary Secretary, I.C.M.I. Congress
Department of Education, University of Exeter
Thornlea, New North Road
Exeter, EX4 4JZ
Devon, England

### International Congress Tour Plans

Two special plans have been arranged by the MAA and the NCTM for members who desire to attend the Second International Congress on Mathematics Education, which is to be held in Exeter, England, from 29 August through 2 September.

A pre-Congress tour will depart from New York for Shannon on 17 August for sightseeing in Ireland, Scotland, and England (with return on 3 September) at a cost—apart from individual arrangements for the Congress—of about $700. Families are eligible to join.

In addition, a charter flight at a round-trip cost expected to be less than $200 is to leave New York on 19 August and return on 5 September.

Brochures giving details of the tour and charter flights are available from the NCTM Washington office.

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The ERIC Information Analysis Center for Science, Mathematics, and Environmental Education produces separate newsletters for three interest groups. If you would like to receive our other newsletters, please complete and return this coupon.

1. Please indicate which newsletter(s) you want to receive.
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## NCTM Forum On Teacher Education

In 1970 the NCTM established a Commission on the Pre-Service Education of Teacher of Mathematics. The concerns of the Commission focus on ways and means to improve the preservice preparation of school mathematics teachers. In conjunction with the NCTM Annual Meeting in Chicago, the Commission will sponsor the first **Forum on Teacher Education** on Thursday, 20 April 1972.

The **purposes** of the Forum are:

- — to identify and analyze innovative practice in the training of elementary and secondary mathematics teachers and
- — provide reactions to the Commission's proposed guidelines for mathematics teacher education.

Invited speakers will:

- — characterize some concerns in today's mathematics teacher education,
- — observe significant needs and trends, and
- — summarize the discussions of the Forum.

Most of the Forum will be conducted in **small discussion groups** focusing on:

- — the presentations of the several Teacher Education Sections scheduled during the program of the Annual Meeting,
- — various innovative approaches currently practiced or recommended, and
- — the purpose and contents of the guidelines for teacher education being developed by the Commission.

For registration forms, write the NCTM Washington Office.

## New AAAS Guidelines

(The following announcement appeared in the CBMS Newsletter; October, 1971.)

A new set of **Guidelines and Standards for the Education of Secondary School Teachers of Science and Mathematics** has recently been published by the Commission on Science Education of the American Association for the Advancement of Science (AAAS). These 1971 **Guidelines** were prepared in cooperation with the National Association of State Directors of Teacher Education and Certification (NASDTEC) in a fifteen-month project that was supported by the National Science Foundation and involved a number of mathematicians, scientists, teachers, NASDTEC members and students.

According to five of the newer guidelines resulting from work by the Commission's seven-member Committee on Mathematics, which was chaired by Professor Malcolm W. Pownall of Colgate University, an undergraduate program for secondary school mathematics teachers should: (1) include a major in mathematics of sufficient depth to make possible further study of mathematics at the graduate level in areas appropriate for teachers; (2) include a substantial experience with the field of computing as it relates to mathematics and to the teaching of mathematics; (3) provide substantial experiences with mathematical model building so that future teachers will be able to recognize and construct models illustrating applications of mathematics; (4) provide the prospective science or mathematics teacher with experiences which require him to seek out and study concepts which are new to him, and then to synthesize written and especially oral expositions of them designed for others for whom these ideas are also new; and (5) develop the capacity and the disposition for continued learning in mathematics and science and the teaching of these subjects. The remainder of the twelve guidelines and four standards in the 1971 report are concerned with the preparation of science teachers, philosophical considerations, and teaching strategies.

The guidelines are addressed to those responsible for the preparation of secondary school teachers of science and mathematics in colleges and universities, to secondary school teachers and administrators, to state departments of education and other accrediting agencies, and to the lay public interested in the improvement of science and mathematics education in the schools. They will be useful only as they are widely discussed by all concerned about science and mathematics teacher education and implemented in teacher education programs. Copies of the **Guidelines** will be sent upon request addressed to:

AAAS Science Education
1515 Massachusetts Avenue, N. W.
Washington, D.C. 20005

## New CUPM Recommendations

The Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America has recently issued a report entitled **Recommendations on Course Content for the Training of Teachers of Mathematics** (1971). These latest CUPM recommendations for the training of prospective elementary and secondary school teachers are based on an assessment of the improvements in mathematics education which have taken place during the 1960's and the changes which can be expected occur in the 1970's. Included in the document are extensive guides for an integrated sequence of courses for future elementary school teachers in which the essential interrelations of mathematics, as well as its interactions with other fields, are emphasized. These courses include a development of number systems, algebra, geometry, probability, statistics, functions, mathematical systems, and the role of deductive and inductive reasoning. The report also contains an outline for a geometry course for secondary school teachers which uses vector spaces as an axiomatic foundation for the investigation of affine and Euclidean geometry.

Copies of the document are available free of charge from:

CUPM Central Office
P.O. Box 1024
Berkeley, California 94701

# Individualized Instruction in Mathematics

We have received many requests for material and information related to individualized instruction in mathematics. The subject index in **Research in Education** provides an easy way to locate ERIC materials on individualized instruction. Readers should not only search under the descriptor "Individualized Instruction," but should also consider related descriptors such as "Autoinstructional Methods," "Programmed Instruction" or "Individualized Curriculum." To locate only those materials related to mathematics, readers should crosscheck mathematical descriptors.

A typical "Individualized Instruction" search will locate many different types of documents in the ERIC system. The reader might wish to begin by considering bibliographies. The following are examples of such documents:

**ED 093 150** SE 008 714

**Bibliography of Individualized Instructional Materials.**

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—Bibliographies, *Individualized Instruction, Instruction, *Mathematics, *Reading, *Sciences, *Social Studies

**ED 046 881** SP 004 622

**Individual Instruction. Bibliographies in Education, No. 13.**

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—*Bibliographies *Individualized Instruction

**ED 047 094** SE 003 304

*Pieronek, Florence T.*

**A Survey of Individualized Reading and Mathematics Programs.**

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—Individualized Curriculum, *Individualized Instruction, Individualized Programs, *Individualized Reading, Mathematics Curriculum, Mathematics Education, *Mathematics Instruction, *Reading Instruction, Reading Materials, *Reading Programs, Teaching Methods

The materials listed in these bibliographies may also be in the ERIC system. When searching for a specific reference, readers should use the author index in **Research in Education.**

Documents containing descriptions of individualized programs in mathematics may also be found in ERIC.

Examples of such documents are:

**ED 041 452** 95 EM 008 084

*Edling, Jack V., Ed.*

**Case Studies: Individualized Instruction.**

Available from—Individualized Instruction Case Studies, Institute for Communication Research, Stanford, California 94305 (250 per case study, minimum order $1. $10 for complete set of 46 case studies. Payment must accompany order)

Document Not Available from EDRS.

Descriptors—*Case Studies (Education), *Elementary Education, *Individualized Instruction, *Secondary Education

**ED 043 488** SE 008 786

*Howes, Virgil M.*

**Individualizing Instruction in Science and Mathematics.**

Available from—The Macmillan Company, 866 Third Ave., New York, N.Y. 10022 ($3.50)

Document Not Available from EDRS.

Descriptors—*Computer Assisted Instruction, Educational Technology, *Individualized Instruction, *Instruction, *Mathematics Education, Multimedia Instruction, Programmed Instruction, *Science Education

**ED 046 742** SE 010 611

*Lipson, Joseph*

**Individualization of Instruction in Junior High School Mathematics.**

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—*Curriculum, Experimental Programs, *Individualized Instruction, *Instruction, *Junior High Schools, Modern Mathematics, *Secondary School Mathematics

Other ERIC documents describe and reference instructional materials that may be used in individualized instruction. Examples specific to mathematics include:

**ED 036 156** 24 EM 007 742

*Wine, William* *Fisher, Jack R.*

**Individually Prescribed Instruction Mathematics Program. Audio-Visual Sources.**

**EDRS Price MF-$0.65 HC-$1.16**

Descriptors—*Audiovisual Aids, Audiovisual Programs, *Individualized Instruction, Instructional Aids, *Mathematics Instruction, *Resource Guides

**ED 038 287** SE 008 137

*May, Kenneth O.*

**Programmed Learning and Mathematical Education, A CEM Study.**

Available from—Mathematical Association of America, 1225 Connecticut Ave., N. W., Washington, D. C. 20036

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—Autoinstructional Methods, *College Mathematics, *Instruction, Instructional Aids, *Instructional Materials, *Programed Instruction, Programed Materials, *Research

Finally, documents which evaluate individualized instruction or which analyze related research are available in the ERIC system. Examples are:

**ED 037 362** SE 008 185

*Meade, William F.* *Griffin, Lawrence M.*

**A Comparative Study of Student Achievement and Other Selected Student Characteristics in a Program of Individualized Instruction in Mathematics and in a Program of Traditional Instruction in Mathematics in Grades 1-6.**

Note—156p.

**EDRS Price MF-$0.65 HC-$6.58**

Descriptors—*Achievement, Attitudes, *Elementary School Mathematics, *Experimental Programs, *Individualized Instruction, *Instruction, Mathematics, Research

**ED 038 318** SE 008 289

*Suydam, Marilyn N.* *Weaver, J. Fred*

**Individualizing Instruction, Set A, Using Research: A Key to Elementary School Mathematics.**

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—*Elementary School Mathematics, *Individualized Instruction, *Instruction, *Mathematics, *Research

Mathematics Education
1240-RF 2228

ERIC Information Analysis Center
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# From The Research Of 1971 On Secondary School Mathematics

In a review of the research on secondary school mathematics, Suydam (1972) summarized findings from the research on secondary school mathematics published from 1930 through 1979. This was presented in question-and-answer format.

This newsletter presents some of the questions and answers from research published during 1971. The focus is on research that the teacher might use; there are other studies of interest principally to researchers, which are not included. An attempt has been made to take into consideration the variability in the quality of research as this newsletter was prepared.

**Does the use of specified objectives facilitate achievement?**

There has been a vast amount of attention in the literature on the use of behavioral objectives, yet comparatively little research attention directed explicitly toward ascertaining their usefulness. In one such study, McCullouch compared the achievement of ninth grade groups using a curriculum based on behavioral objectives and groups using a standard textbook program (which was also based on objectives, though presumably not behaviorally-stated objectives). He found no significant differences in their achievement, though groups using the behavioral objectives curriculum made greater progress in arithmetic fundamentals and reasoning.

Collins reported that use of either a list of specific objectives or diagnostic-progress tests was sufficient for a significant increase in mastery of objectives by seventh graders. Eighth graders also profited from the use of alternative resources.

**How effective are individualized procedures?**

Various types of procedures which attempted to individualize instruction in various ways for various groups of students were studied. Because of the variability, it is difficult to make any generalizations.

Baker reported no significant differences in achievement, confidence, or interest between groups of low-achieving ninth graders who selected their own activities and those who could select problems or had no choice. The students most frequently chose teacher-made assignments for the activity. He suggested that this may indicate a strong dependence of the low achiever on the guidance and direction of the teacher.

Bull studied an individualized geometry program in which the student paced his own learning, chose learning experiences to attain teacher-established objectives, and took tests when he felt prepared, with the teacher primarily helping individuals and small groups. He found that the mean score of classes taught by the individualized method was significantly higher than that of classes taught by the traditional method.

Gould found that achievement gain for ninth graders taught two days a week under a "supervised study" plan with assistance from fellow students in small groups, was significantly greater than that of students taught under a "daily recitation" plan. No significant difference in change in attitude toward mathematics was found between the two groups.

Olson found that achievement and attitude were not significantly different in geometry classes in which students studied in pairs or alone. On a related topic, Ellis found that for classes in grades 9 through 11 in which above-median students tutored below-median students, greater achievement gains were made than in classes in which tutoring was not used.

Eighth grade students were classified as having inductive or deductive learning styles by Gawronski. She then gave them programs which were developed inductively or deductively. No significant differences in achievement were found between groups, whether or not they had programs compatible with their learning style.

Gussett found that materials for seventh graders which used "non-standard" English were as effective as regular text materials.

**How do "modern" and "traditional" programs compare?**

Norland compared sixth and eighth grade groups for the 1968-69 school year, who had five or more years of instruction using modern mathematics, with their counterparts for the 1964-65 school year, who had instruction using primarily traditional materials. In general, students who had a traditional program scored significantly higher on com-

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putation tests, in six out of ten cases, than those who had a modern program. In only one case did significant differences favor the modern group. On tests of problem solving, the traditional groups were significantly higher in three of ten cases, and in only one case was the modern group significantly higher. In other cases, there were no significant differences.

**What is the role of activity approaches in mathematics?**

Vance and Kieren summarized recent research on mathematics laboratories by noting (1) the research indicates that students can learn mathematical ideas in laboratory settings; and (2) there is only limited evidence that laboratories promote better attitudes toward mathematics, though most students seem to prefer laboratory approaches to more class-oriented approaches.

Recent studies have not indicated that higher achievement can necessarily be expected from activity approaches. In a study with disadvantaged low achievers in grades 7 and 8, Cohen found that use of a conventional textbook/chalkboard/discussion approach resulted in a significant increase in achievement, when compared with a group taught using a laboratory approach with a variety of manipulative and multi-sensory materials.

Johnson also reported on the use of activity-oriented lessons with seventh graders. Such instruction did not appear to be more effective than instruction with little or no emphasis on activities for units on number theory, geometry, measurement, and rational numbers, though activities did aid in the learning of some concepts by low and middle ability students.

**What procedures are effective for geometry?**

While research has been directed toward facets of each course in the secondary school mathematics program, many studies were focused on geometry. Kort evaluated an innovative transformation approach to geometry. For students in eleventh-grade mathematics classes, it was found that those who had studied tenth-grade geometry using a transformation approach showed some retention and transfer advantages over those students who had used a non-transformation approach in their study of tenth-grade geometry. He suggested that tenth-grade geometry should be changed to extensively utilize transformations only if subsequent mathematics courses are altered to capitalize on a background in geometric transformations.

Solheim found that the attitudes of tenth grade groups studying transformations of the plane became more negative over a five-week period, while those of groups studying traditional topics were unchanged. Attitude toward geometry and achievement in geometry were found to be significantly related.

Hershberger compared the effects of a vector and a non-vector approach used with analytic geometry students for thirteen days. No significant differences were found between the approaches on immediate achievement or retention measures, though those using the vector method did significantly better on the transfer test.

Martin, in a study with 2,000 tenth graders and 43 teachers, found no significant differences in the critical thinking skills of students using "ledger" or "flow-proof" methods of structuring proofs.

Lorentz reported that, for geometry content, material in which explanation followed definition was not as effective as material developed in an explanation-definition-explanation pattern, explanation preceding definition, or definition alone.

**Does the learning of logic have a "pay-off"?**

Shumway examined the effect of negative instances on the acquisition of mathematical concepts. In a 65-day study, one group of eighth graders was given both positive and negative instances of concepts pertaining to geometry, exponents, and operations, while the other group had only positive instances. Differences in performance favored the group having negative as well as positive instances. A "pay-off" from the inclusion of negative instances in the development of concepts pertaining to number operations appears to be a decreased tendency for students to overgeneralize properties associated with such operations.

Knowledge of symbolic logic (taught via programmed instruction) led geometry students to an improved understanding of the logic-based mathematics they had studied before learning the symbolic logic, and to following work. In algebra class, it took teacher encouragement along with a knowledge of symbolic logic, to produce significant results, according to Sharlow.

Roy used a unit on logic and proof to present the concept of validity and methodology of proof to one group of seniors, while a chapter of a college freshman text was used to present notions of informal reasoning and the nature of a deductive science or axiom system to another group. The groups were not different in their ability to determine the validity of given arguments or to prove theorems using the principle of mathematical induction.

**In what ways are computers facilitating mathematical achievement?**

A great amount of research attention was directed during the use of various aspects of computer-assisted instruction. This research dealt with both non-tutorial and tutorial CAI, as well as with the status of computer use in mathematics.

Bishop interviewed teachers from twenty schools which were using the computer in mathematics programs, and derived other data from a questionnaire returned by 100 teacher education institutions in Missouri and adjoining states. He found that 30 per cent of the secondary schools offered technically-oriented computer-related courses in their mathematics curriculum. Only one of the schools used computer-assisted instruction in a tutorial role. Twenty per cent used the available computer time for enrichment of and in support of courses previously existing in the mathematics curriculum. About two-thirds of the colleges included a computer-related mathematics course as a recommended part of the teacher education curriculum. The teachers felt that methodology in using computer time in their mathematics courses was their principal need.

In a study conducted by Ronan, students in one middle-ability algebra-trigonometry class used the computer for one semester as a computational tool, using the language BASIC. Their achievement was compared with that of students in a class which did not use the computer. There was no significant difference between the mean achievement of the two groups after study of (1) algebraic review material and radicals in equations, (2) trigonometric functions and complex numbers, and (3) circular functions and their inverses. The students who used the computer did attain a significantly higher level of achievement after study of exponential functions and logarithms. There was no significant difference between groups in ability to apply mathematical concepts or in problem-solving. Students who used a computer attained a significantly higher level of achievement in mathematical skills and in logic and reasoning ability than those who did not use a computer.

For two second-year algebra classes taught with computer applications (using BASIC), Hoffman found no evidence that use of the computer significantly affected generalization skills or achievement, except for certain simple analysis skills.

Katz compared the effects of two computer-augmented methods of instruction with traditional instruction, using nine average-ability second-year algebra classes. One group wrote computer programs in conjunction with the regular classroom presentation of algebra. Programs were run on the computer by aides, and then returned to pupils. A second group also wrote computer programs, but ran their own programs on the computer, with time spent in the computer room taken from classroom instructional time. Those who ran their own programs scored significantly lower than the other experimental group or the regular instruction group on a full-year standardized test. On tests of only the topics that were related to computer-program-writing, there were no significant differences for any group. Katz concluded that the most effective method of computer utilization appeared to be program-writing with no direct computer access.

Pack also studied the effects of three modes of computer use: (1) time-sharing, involving conversational interaction between the computer and students who were simultaneously using it; and two batch procedures, in which students prepared programs on paper tape and submitted them to a monitor for batch processing—(2) quick batch, in which results were received within an average of eight minutes, and (3) slow batch, in which students received their results the following day. Thirty-six high-ability students rotated through the three modes, spending ten hours in each, working on a common set of problems. No significant differences were found in scores on a basic computer language test or on number of problems solved. Students preferred time-sharing, with quick batch as a second choice and slow batch least preferred.

In a study with 38 seniors, Ostheller found that those who were taught a unit on probability and statistics via a tutorial computer-assisted instruction program achieved as well as groups taught by programmed or regular textbooks. No significant differences were found in attitude, though students preferred student-teacher interaction to CAI.

A CAI program used in a one-semester ninth-grade mathematical skills course was found to be effective in improving computational skills in whole numbers, fractions, decimals, and per cent, and in improving attitude toward mathematics, Cole reported.

#### What type of homework is effective?

Laing found no significant differences in achievement and retention between eighth-grade groups in which practice on a topic was massed in one homework assignment or distributed over several. There was a consistent trend favoring distributed practices.

Urwiller found no significant differences in achievement or attitude between groups who used spiral homework assignments (with problems assigned at spaced intervals) or traditional homework assignments (with problems from each day's lesson as well as problems from previously-taught material) in second-year algebra. Both groups made significant gains during the year, and retained at the 98 per cent level over the summer.

Three modes of assistance used by students while doing geometry homework were studied by Lash. The group getting complete solutions achieved lower scores than groups getting hints or answers or no assistance.

#### What techniques are helpful in developing tests?

Coppedge and Hanna analyzed geometry test questions to determine the degree of agreement between distractors for multiple-choice items and the discriminating errors that students made on completion items. Students were administered a test in completion format; teachers were asked to generate three distractors to be used if the item were in a multiple-choice format. There was much variability in teachers' ability to provide the most discriminating distractors, and to differentiate popular distractors from highly discriminating distractors. It was suggested that, as an alternative way of improving the quality of multiple-choice tests, distractors be developed from wrong answers which discriminate between high and low achievers on tests in completion format.

Hanna also reported that multiple-choice items in which tenth-grade students selected (1) what was given and what was proved or (2) the "reason," were recommended over items which merely required the student to note whether a statement could be proved.

#### What is the affective status of students of mathematics?

Callahan reported that 20 per cent of the eighth graders he surveyed felt that they disliked mathematics, 18 per cent were neutral, while 62 per cent liked it. The need for mathematics in life was named most frequently as the reason for liking it; not being good in mathematics was cited most often as the reason for disliking it.

Data from the International Study of Educational Achievement indicate small correlations between achievement and attitude, reported Postlethwaite.

#### How may successful problem solvers be identified?

Dodson attempted to describe successful "insightful" mathematics problem-solvers, using evidence on tenth graders from the NLSMA data bank. Among the eleven "strongest" characteristics of successful problem-solvers were high scores on reasoning tests, good spatial relations ability, ability to discriminate critical elements, divergent thinking, low test anxiety, and a positive attitude toward mathematics. He made some suggestions for the development of insightful mathematics problem-solving ability, such as emphasis on solving geometry problems which require students to synthesize a large number of seemingly unrelated geometric ideas.

#### What patterns of teacher-behavior have been described?

Strickmeier described patterns of teacher verbal behaviors in seventh grade mathematics classes grouped by ability, and compared teachers' perceptions of their verbal behaviors and expectations of students for classes of different ability levels. He found that although the ten teachers he interviewed and observed had different perceptions and expectations for classes of different ability levels, such differences were not reflected by observable differences in the teachers' verbal behaviors.

Lockwood identified elements that would be helpful in explaining the question-asking behavior of teachers in the classroom. Using audio-tapes of 47 class sessions in grades 7 through 11 involving four carefully selected mathematics teachers, he identified 16 cues (stimuli which act as signals to ask a question) and 17 factors (elements that have an influence with respect to what question the teacher asks). He also identified, in terms of combinations of cues and factors, two general relations which were helpful in explaining and predicting teacher questioning: the "go-ahead" relation and the "modification" relation.

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*"DAI" refers to *Dissertation Abstracts International.*

A complete annotated listing of studies published during 1971 will be available both from the ERIC Information Analysis Center for Science, Mathematics, and Environmental Education and in the November 1972 issue of the *Journal for Research in Mathematics Education.*

## Mathematics Laboratory Project Underway

The staff of ERIC/SMEAC has begun work on a special mathematics laboratory project. This project will identify and disseminate innovative practices in mathematics teaching via an activity or laboratory approach. The primary thrust of the project will be the preparation of a general handbook on mathematics laboratories and activity learning addressed to mathematics education specialists. This handbook will include rationale and objectives for activity learning in mathematics, a review of procedures for establishing activity learning programs in mathematics, a review of research on activity learning, and a large resource section containing descriptions and explicit instructions for activities for mathematics classes organized by content topic and grade level.

Mathematics education specialists will review and evaluate the general handbook. In accordance with their evaluations, the original resource materials in the handbook will be revised to form two target publications for classroom teachers of mathematics. These publications will be targeted to teachers of disadvantaged low-achievers in mathematics (grades K-9), and to teachers of exceptional children in mathematics (grades K-9). The two final resource publications will provide a new source of carefully evaluated teaching materials which have the potential of significantly changing educational practices in the teaching of mathematics to disadvantaged low-achieving students and to exceptional children (disabled or mentally handicapped students).

We are now well into the process of collecting noncommercial and teacher-made materials for mathematics laboratories, K-9. We are looking for printed materials, but we assume that most of these will describe some physical materials that can be easily obtained or constructed by classroom teachers. For the present we are interpreting "laboratory activities" in a very broad sense. Descriptions of teaching devices, sets of activity cards, equipment for demonstrations or games, and data sheets or work sheets are commonly provided. However we do not use problem sheets or problem lists that do not refer to some equipment or paper and pencil constructions as aids for problem solving. Our staff edits and adapts all the contributions to fit a standard format. We hope to provide very concise descriptions so that teachers can rapidly examine several ideas. To date, we have received approximately 2000 pages of materials from readers of our newsletter and from creative mathematics teachers they have identified for us. We would like to receive even more materials, however, and encourage our readers who have not already contributed to the project to do so now.

Many of the materials we have received are extensive self-contained laboratory units. These materials will be announced in future issues of **Research in Education** and will be available from the ERIC Document Reproduction Service. We anticipate that final versions of the project handbooks will be available by spring or summer, 1973. Future issues of the newsletter will contain progress reports for the project as well as the availability of materials.

## About Mathematics Laboratories

Readers who are interested in our mathematics laboratory project will also be interested in a recent paper, **About Mathematics Laboratories**, announced in a recent issue of Research in Education. Authored by William M. Fitzgerald of Michigan State University, this 33 page paper traces the growth of the concept of a mathematics laboratory and reviews recent research and developments in this field. The first section quotes several interpretations of the term and discusses some of the activities advocated by its proponents. The second section quotes extensively from E. H. Moore (1902) and McLennan and Dewey (1895) to show that the idea is older than the present influence of Piaget, Bruner, Gattegno, etc. A section of quotations from more recent advocates of mathematics laboratories is followed by a review of research on the use of manipulative materials, desk-calculators, and science-linked courses; the correlation of motivation with achievement; and the practical difficulties of implementing a laboratory approach in a school. The final sections discuss laboratory materials and the use of laboratory methods in teacher training. The paper was originally commissioned by School Mathematics Study Group.

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## Two New Prep Reports of Special Interest to Mathematics Educators

PREP (Putting Research into Educational Practice) is a series of monthly reports which synthesize and interpret research, development, and current best practice on specific educational topics. Intended as a format for disseminating significant findings to the practitioner quickly, these reports are targeted to specific educational audiences—the administrator, school board member, teacher, curriculum specialist, and teacher educator. The following recent PREP reports may be of special interest to mathematics educators.

### PREP NO. 28: EDUCATIONAL PERFORMANCE CONTRACTING

PREP No. 28 reports on the general concepts of educational performance contracting, types of contracts, contracts selection, and some of the current programs in contracting for student achievement. It has been included in the PREP series in order to provide educators with research based findings on this new technique. It was adapted from a study on performance contracting which was conducted for HEW by J. P. Stucker and G. R. Hall of the Rand Corporation, Santa Monica, California.

### PREP NO. 30: TEACHING RESOURCES FOR LOW-ACHIEVING MATHEMATICS CLASSES

The ERIC/SMEAC paper, Teaching Resources for Low-Achieving Mathematics Classes, by Kenneth J. Travers, John W. LeDuc, and Garth E. Runion has now been adapted as No. 30 in the series of PREP Reports. As a result, this paper, which we announced in our previous newsletter, will have a wide distribution among educational practitioners. The paper reviews teaching approaches and general resource materials for low achievers in both elementary and secondary school mathematics classes. Two bibliographies are included.

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# From The Research Of 1971 On Elementary School Mathematics†

Each year research answers some of the questions which both classroom teachers and other mathematics educators have about the teaching of elementary school mathematics. Suydam and Weaver (1970, 1971) have summarized previous research: this newsletter presents some of the answers from research published during 1971. The focus is on research that the teacher might find useful. Other studies, of more specific information to researchers, are not included.* As this bulletin was prepared, the variability of the quality of research was taken into consideration.

**How effective are various teaching strategies?**

Wilkinson compared the use of laboratory procedures with conventional instruction. One experimental treatment involved the use of laboratory units as a method of instruction. The laboratory units contained worksheets and manipulative materials; pupils were required to experiment with physical materials, collect data, and generalize the findings based on the data. In a second experimental treatment, cassette tapes were provided which contained a verbatim recording of all directions and questions on the laboratory worksheets. The control group was taught in a more conventional setting, using the textbook and teacher to provide the content and direction for the geometry lessons. No significant differences in achievement or attitude were found between the sixth grade groups using conventional instruction or either of the two types of laboratory procedures.

Broussard found that fourth grade students in inner-city schools given individually prescribed work through independent study, small-group discussions, large-group activities, and teacher-led discussions achieved significantly higher in skills and concepts than those taught by a traditional textbook, class-group method.

A number of studies explored aspects of the continuing question, "How effective is discovery-oriented teaching when compared with expository teaching?" Barrish tested the hypothesis that "high-divergent" students would score higher on tests after instruction under an inductive-guided-discovery strategy than those encountering a deductive-reception strategy, while the opposite would be true for "low divergent" students. The 20-day study was conducted with 125 fourth, fifth, and sixth grade children; this was followed by a retention test after 20 more days. Ten test problems called for "high cognitive" responses involving some degree of transfer, application in novel situations, or independent thinking. The remaining 25 problems were termed "low cognitive." They required recall and manipulations of algorithms in examples similar to those used in the lessons. It was found that levels of divergent production were not related to either initial learning or retention of the mathematical generalizations taught, regardless of the strategy presented. For the learning of low cognitive mathematical material, the deductive-reception strategy proved superior.

Scores of sixth graders who were taught geometry concepts with a discovery method increased over time, while scores of students taught with an expository method decreased, according to Scott.

Bassler, Hill, Ingle, and Sparks administered programmed mathematics units to students in grades 4, 6, and 8. The units differed in the amount of "guidance" which was provided. No reliable differences were found between maximal and intermediate amounts of guidance in the materials.

When data from an earlier study (Worthen, 1968) were reanalyzed with the unit of analysis changed from pupil scores to class means, no significant differences between expository and discovery strategies were found by Worthen and Collins.

Robertson found that fourth grade pupils who had seven months of expository instruction achieved significantly higher on computation tests, while those having discovery instruction scored significantly higher on the retention test on applications. Attitudes were significantly higher for the discovery group. The teachers were able to adapt to new techniques and procedures, and teacher behaviors in the discovery approach differed significantly from those in the expository approach. Robertson concluded that "it would appear that **no one treatment or mode of instruction can be considered the best approach.** The teacher who learns as many instructional modes as possible, identifies and diagnoses pupil needs and abilities, and uses this knowledge to individualize instruction may very well get the best results."

† Prepared by Marilyn N. Suydam, Faculty Research Associate, ERIC/SMEAC

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**How do pre-school and kindergarten children acquire mathematical ideas?**

As in previous years, the studies which focused on Piagetian theory were variable in both topic and findings. Many were concerned with types of training, largely on conservation. An even greater number measured the stages and ages of development, again with most related to conservation, but a few on topics such as transitivity and implication-reasoning. Several focused on the relationship of conservation and race, SES, age, verbal ability and similar factors. Learning style was considered in one case. The findings of these studies have value to future researchers, and to those who are attempting to block out the "map" of the Piagetian realm, but little clear evidence that is useful to the classroom teacher has been added.

Carr reported no significant differences were found on four Piaget-type tests between kindergarten groups who used Bereiter-Engelmann materials for two, one, or no years. The program appeared to be more effective for kindergarten children than for pre-kindergarten children. The four tests assessed the child's ability to conserve number, to discriminate, to seriate, and to enumerate.

In a continuing set of reports on a survey of kindergarteners, Rea and Reys reported specific data on knowledge of children in the areas of geometry, number, money, and measurement. Use of an **informal but planned** sequence of experiences was recommended.

**How do children achieve with various types of mathematical sentences and algorithms?**

Engle and Lerch reported on a study designed to ascertain whether first graders could make correct decisions about basic addition ideas stated as either true or false number sentences. A test was developed, with one part having addition combinations stated in the form

$$\begin{array}{r} 4 \\ +3 \\ \hline \end{array}$$

and $3 + 4 = \square$, and the other part composed of closed addition sentences, for which pupils were to indicate whether each was true or false. First graders who had studied in programs without emphasis on closed number sentences could make decisions about basic addition facts stated as either true or false number sentences with a reasonably high degree of accuracy. No significant difference was found in their ability to answer the computational-type addition and their ability to make correct decisions about closed sentences concerning similar addition ideas.

Weaver analyzed the relative difficulty of various open-sentence types. He found that sentences of the form $\square - b = c$ or $c = \square - b$ were significantly more difficult than were sentences of the form $\square + b = c$ or $c = \square + b$ for children in grades 1 through 3. He also found that the position of the placeholder in the sentence affected the difficulty of the sentences. That is, sentences of the form $a + \square = c$ were less difficult than sentences like $\square + b = c$.

Steffe and Johnson found that mean scores for problems of the type $a + b = \square$ were higher than for the three other problem types studied: $a - b = \square$, $a + \square = c$, and $\square + b = c$. They also reported that first graders solved problems with no described action as well as they solved problems with described action.

Trafton investigated the effects on third grade pupils of two initial approaches to two-digit subtraction. One approach consisted of the conventional decomposition algorithm. The second approach involved a more general method based on the main concepts of subtraction and using the number line as an aid to solution, before work with the decomposition algorithm. The "general" approach did not result in greater understanding of or performance with the decomposition algorithm than did prolonged development of the algorithm.

Aims reported that the number of frames to the left of the equality sign and the arrangement of operators ($+$, $-$, $\times$, $\div$) affected the time needed to solve arithmetic examples, but the number of possible solutions did not significantly affect time. He analyzed data from students in grades 4 through 8.

**What is the role of materials in mathematics?**

The role of materials in the learning of mathematics is being questioned by teachers at all levels today. Generally, we are bound philosophically to their use: but research increasingly indicates that we need to analyze **when** they are used, **with whom** they are used, **what types** should be used, and **how** they are used.

Bisio, conducting a study with 29 classes of fifth graders, compared three methods of teaching addition and subtraction of like fractions. In one treatment neither the teacher nor the students used manipulative materials. In the second treatment, the teacher used the manipulative materials as a demonstration for the students. And in the third treatment, both teacher and students manipulated materials. Children taught with manipulative materials, both **using** them **and** passively watching them being used, scored higher than those not using materials.

Knaupp also found that both teacher-demonstration and student-activity modes, using blocks and sticks in presenting addition and subtraction algorithms and ideas of base and place value to four second grade classes, resulted in significant gains in achievement.

The assumption that the use of materials can contribute significantly to the learning of mathematics was also investigated by Carmody. She studied three sixth grade classes who were assigned to concrete, semi-concrete, and symbolic treatment groups for an 11-day unit on selected numeration and number properties. Support was found for the use of concrete or semi-concrete approaches over symbolic approaches if the goal of instruction is transfer.

Johnson assigned three treatments to students in grades 4, 5, and 6 who were studying perimeter, area, and volume. The "Maximum" treatment used a semi-programmed text and two sets of physical models and instruments for each child; students were directed by the text to make use of the objects and were free to use them at other times as well. In the "Moderate" treatment, students used the programmed text, including all drawings and illustrations, but were not given the models. In the "Minimum" treatment, all drawings and illustrations were removed and verbal descriptions were substituted; no models were given. He reported that a high degree of concreteness resulted in higher mean achievement and retention scores.

**How useful are mathematics tests?**

After analyzing a standardized mathematics test, Gridley reported that mathematics achievement in grades 2-5 as measured by the test appeared to consist of several empirically defined clusters of items. The clusters varied from grade to grade, and subtest headings did not represent distinct clusters. The meaningfulness of the total score, as well as the subtest scores, was questioned, since several skills or abilities were being measured.

**What factors affect problem-solving ability?**

Kamins attempted to determine if the appearance of familiar settings, things, people, and subjects in the language of word problems would affect the success of black children from a lower socio-economic environment in solving word problems. For the 32 fifth graders involved, no significant difference in achievement was found between use of problems written by children and textbook problems. (However, in another study outside the problem-solving context, Knight found that pupils taught and assessed using a sub-culturally appropriate language in a unit on non-metric geometry performed more successfully than those taught and assessed using standard language in the primary grades.)

Nickel devised a multi-experience approach to verbal problem solving, using abstract, representational, and concrete materials. This was more effective for fourth graders than a strictly verbal approach.

Four variables which significantly affected the difficulty of word problems were identified by Loftus: number of operations, sequence of problems, complexity, and conversions. Verbal clues, order of operations, and number of steps had little effect on difficulty level. For the study, she used a computer-based teletype-presented program of 100 problems, and analyzed data from 16 sixth graders.

Cromer analysed the difficulty of multiplication problems for fifth graders. He found that difficulty level could be predicted by problem characteristics such as order, digital, or process variables.

**What do studies on the vocabulary of textbooks show?**

Willmon found a total of 473 technical mathematics words in 24 textbooks for grades 1-3, with frequency of use ranging from 1 to 5,995. Seventeen words were repeated more than 1,000 times, but most were used less than 25 times. Stevenson reported that, of 396 technical and semi-technical words he found in third grade mathematics textbooks and first and second grade readers, only 51 were used in both reading and mathematics books. However, 161 words were common to all four mathematics textbooks. Data from a study by Browning is less encouraging. She found a total of 743 mathematical terms in 15 textbooks used in grades 4, 5, and 6; only 10 words were common to all textbooks.

These studies indicate that every teacher of mathematics must consider the reading problem which a child may face. Smith added further evidence on this point. He found that the composite readability scores for sixth grade textbooks ranged from 5.0 to 5.8; however, analysis of selections indicated a range of below grade 4 to grade 8. Tests ranged only from below grade 4 to grade 6 in reading level.

In a different type of vocabulary study, Olander and Ehmer administered a test from 1930 to pupils in 1968. On the Buswell-John Vocabulary Test, 1968 pupils achieved higher scores on 74 of 100 items in grade 4, 59 items in grade 5, and only 48 items in grade 6 than did pupils who had taken the test in 1930. On a test of contemporary terms, mean scores were 49 for grade 4, 58 for grade 5, and 64 for grade 6 on the 100 items.

**What type of homework is helpful?**

The evidence on this topic is still rather nebulous. Grant found no significant differences in achievement between fifth grade groups given differentiated homework on two levels of difficulty, textbook assignments, or no homework. Gray and Allison also reported that no significant differences were found when students were given three or no homework assignments per week in grade 6.

**What is the status of children's attitudes toward mathematics?**

Deighan, in a study with students in grades 3, 5, and 6, found that attitude toward mathematics was not significantly related to mathematics achievement, nor was there a significant relationship between teachers' and students' attitudes. A significant decrease in students' attitude scores across grades was found. Malcolm similarly found that attitudes toward mathematics became less positive from grade 3 through grade 7.

Findings such as these have been reported in the past—but there are other studies which present differing evidence. There are obviously many factors involved when attitudes are measured: the type and quality of the instrument used for the measurement, what has occurred to the children immediately prior to administration of the instrument, and numerous other points could be noted. For any one teacher it is less important to know how children in general feel about mathematics than it is to know how a specific class feels—and the attitude of a single group can usually be judged in many ways by their teacher . . .

*** For other studies . . .**

Many other studies might have been cited—for instance:

Weeks reported that training with attribute blocks for eight weeks in grades 2 and 3 had a strong positive effect on logical and perceptual reasoning ability.

Sension found that area, set-subset, and combination representations for introducing rational number concepts appeared to be equally effective on tests containing items consistent with the experimental instruction. However, the combination treatment produced a higher level of generalization to a number line model.

Sowder found that pupils in grades 4-7 needed about three to six instances to form generalizations of the sort tested from numerical situations. Only rarely were generalizations formed after six unsuccessful instances.

A complete annotated listing of studies published during 1971 is available from ERIC/SMEAC and also in the November 1972 issue of the **Journal for Research in Mathematics Education.**

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**"DAI" refers to *Dissertation Abstracts International*.

## Compilations and Reviews of Research

If you are interested in securing copies of compilations of research on elementary and secondary school mathematics, here are some sources:

1. "An Evaluation of Journal-Published Research Reports on Elementary School Mathematics, 1900-1965." Volumes I and II. M. N. Suydam, unpublished doctoral dissertation, The Pennsylvania State University, 1967. Microfilms Abstract Order No. 68-3563; available from Xerox University Microfilms, Dissertation Copies, P. O. Box 1764, Ann Arbor, Michigan 48106; cost, $4 for microfilm and $10 for xerography.

   This initial study contains categorized, annotated, and evaluated reports of 799 studies (grades K-8) plus a list of approximately 700 dissertations. Bibliography.

2. "Interpretive Study of Research and Development on Elementary School Mathematics, Phase I." M. N. Suydam and C. A. Riedesel, Final Report, June 1969.

   Volume I, Introduction and Summary: What Research Says. ED 030 016. 255 p. Microfiche (MF), $0.65; Paper Copy (HC), $9.87

   Volume II, Compilation of Research Reports. ED 030 017. 331 p. MF, $0.65; HC, $13.16

   Volume III, Developmental Projects. ED 030 018. 232 p. MF, $0.65, PC, $9.87

   Available from ERIC Document Reproduction Service (EDRS), Leasco Information Products, Inc., P. O. Drawer 0, Bethesda, Maryland 20014.

   Volume I contains synthesized research findings in the form of answers to numerous questions. Volume II contains categorized, annotated, and evaluated reports of studies and dissertations for 1900-1968, extending the list of those cited in the dis-

sertation above. In Volume III are summaries of projects, with typescripts of interviews with nine project directors. Bibliography in Volumes I and II.

3. "Using Research: A Key to Elementary School Mathematics." M. N. Suydam and J. F. Weaver, 1970.

   This set of 11 bulletins synthesizing research findings is available by individual titles from EDRS; the complete set of bulletins is currently out of print. An updated collection is anticipated and will be announced in this Newsletter when it is available.

4. "Annotated Compilation of Research on Secondary School Mathematics, 1930-1970." M. N. Suydam, Final Report, February 1972.

   Volume I, Introduction; Compilation of Articles. ED 062 165. 407 p. MF, $0.65; HC, $16.45

   Volume II, Compilation of Dissertations; Summary and Conclusions. ED 062 166. 411 p. MF, $0.65; HC, $16.45

   Available from EDRS at cost cited above; also available from The Center for Science and Mathematics Education, The Ohio State University, 244 Arps Hall, Columbus, Ohio 43210 at a cost of $8.50 for the set of two volumes.

   Volume I contains categorized, annotated, and evaluated reports on 780 studies (grades 7-12), while 770 dissertations are similarly presented in Volume II. Some studies for grades 7-8 were included in previously completed elementary compilations. Bibliography in each volume.

5. "A Review of Research on Secondary School Mathematics." M. N. Suydam, March 1972.
   Available from EDRS, document SE 014 234, 229 p., MF, $0.65, HC, $9.87; also available from The Center for Science and Mathematics Education, address above, at a cost of $3.50

   This is a review of research findings in the form of answers to numerous questions. Bibliography.

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A twelve-page guide entitled "ERIC: How to Use It for Mathematics Education" has been developed by and is available from ERIC/SMEAC. The guide presents a summary of pertinent information concerning the ERIC system, with emphasis on mathematics education functions and is directed primarily to those individuals needing a ready digest of ERIC services and procedures.

Single copies are available at no cost from ERIC/SMEAC. Similar documents are available through ERIC/SMEAC for science education and for environmental education.

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# ERIC: Information is a Two-Way Route

The ERIC system was designed to

1—collect information

2—disseminate information

## —ONE WAY→

Where do the documents that form the information base come from? The answer is obvious: from a variety of sources, including:

—research and development projects which were federally funded

—school systems and other educational agencies

—educational organizations

—individuals

—conferences and other meetings

—educational journals

The staff at ERIC/SMEAC encourages you to send us materials which you feel are of interest to other educators —research reports, conference speeches, experimental student materials, evaluation and assessment reports, course descriptions and syllabi, curriculum guides, or bibliographies. The steps for submitting materials to be abstracted and indexed in **Research in Education** are the same for all ERIC Clearinghouses:

1—Send two complete mimeographed or printed, legible copies of the document. Ditto, faded, or dirty copies can not be used.

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In RIE we attempt to announce all significant documents on the learning and teaching of mathematics education. Any document that you send will be examined for reproducibility, completeness, copyright and availability limitations, scope suitability, significance for a national audience, and its value in advancing the state of knowledge about mathematics education. A document may have great worth but not be abstracted for RIE because it does not satisfy one of these selection criteria. If it is not abstracted for RIE but is within the scope of the ERIC system, we keep it in the ERIC/SMEAC library, where it is available to users.

## —THE OTHER WAY→

The dissemination of information by ERIC is also many-faceted. RIE and CIJE are the cornerstones of this process. Computer searches of the document base are also increasingly being used; we are planning a document, "ERIC: How to ACCESS It," which will give you specific information on these. To an extent, limited by our small staff, we'll try to answer your specific questions when you write or call us. And workshops and discussions on how to use ERIC are also scheduled at many local and national conferences.

## See for yourself . . .

The centerfold of this Newsletter contains a selection of actual abstracts from **Research in Education** (RIE). RIE is a monthly publication of the ERIC system; you can find it in most libraries and it's also available by subscription from the Government Printing Office.

The abstracts included here represent only a small sample of more than 300 documents on mathematics education which were cited in RIE during 1972. Those with "HC" (xerography) or "MF" (microfiche) prices may be purchased from EDRS, P. O. Drawer 0, Bethesda, Maryland 20014. Alternate sources are cited on some abstracts.

ERIC/SMEAC also abstracts articles in a designated set of journals; these abstracts are included in **Current Index to Journals in Education** (CIJE). CIJE is found in most libraries and is also available by subscription from CCM Information Corporation, 866 Third Avenue, New York, New York 10022.

SE 017 936

# CENTER CLIPPINGS...

Here are some of the documents on mathematics education recently announced in Research in Education. There's much variety!

from ERIC/SMEAC

ED SE 014 840
Weaver, J. Fred. Suydam, Marilyn N.
**Meaningful Instruction in Mathematics Education.**
Pub Date June 72
Note—73p.
Available from—ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, Columbus, Ohio
**EDRS Price MF-$0.65, HC-$3.29**
Descriptors—Algorithms, *Elementary School Mathematics, *Instruction, *Learning Theories, Literature Reviews, *Mathematics Education, *Research Reviews (Publications), Teaching Procedures
This monograph focuses on the influence of meaning theory on elementary school mathematics programs and on mathematics instruction. Theories of arithmetic instruction up through 1935 are described and the philosophy of meaning theory, contributions and discussions by mathematics educators, and applications to actual instruction are delineated for the period from 1935 through 1960. A discussion of the implicit concern for meaning in the modern mathematics movement during 1960 to the present concludes the first section. The second section summarizes studies that establish and affirm the importance of and need for meaning and studies that explore the effect of teaching various procedures with meaning. The final section of the paper briefly discusses the implementation of mathematically meaningful instruction. An extensive bibliography is included.

Meaningful Instruction

ED SE 014 918
Aiken, Lewis R., Jr.
**Language Factors in Learning Mathematics.**
Pub Date Oct 72
Note—47p.
Available from—ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, Columbus, Ohio
**EDRS Price MF-$0.65, HC-$3.29**
Descriptors—Achievement, Learning, *Mathematics Linguistics, Mathematical Vocabulary, *Mathematics Education, Problem Solving, *Readability, *Research Reviews (Publications), *Verbal Ability
This paper focuses on the relationship of verbal factors to mathematics achievement and reviews research from 1930 to the present. The effects of verbalization in the mathematics learning process are considered; mathematics functioning as a unique language in its own right is analyzed. Research on the readability of mathematics materials and research relating problem solving abilities to verbal abilities are reviewed. An extensive bibliography is included. (Editor/DT)

Language and Mathematics

ED 065 339 SE 014 404
*Lockhart, John*
**Guide for Volunteers in Mathematics.**
Oklahoma City Public School System, Okla.
Pub Date 71
Note—73p.
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Activities, *Arithmetic, *Elementary School Mathematics, *Instruction, Instructional Aids, *Instructional Materials, Learning Activities, Paraprofessional School Personnel, Tutoring, Volunteers
This document is intended as a guideline for volunteers who work with elementary children in mathematics in the Oklahoma City School System. Following referral and progress sheets designed to increase teacher-volunteer communication about the student, the bulk of the book is a list of involvement activities to assist volunteers in helping students in mathematics. These activities cover elementary topics that have been identified as problem areas: number concepts, place value, the four operations with whole numbers, fractions and their equivalents, and the four operations with fractions. The activities generally allow the student to "do" something, and materials are inexpensive and easily prepared. (JM)

Tutoring Guides

ED 065 338 SE 014 403
*Swanson, Mary T. Taylor, June*
**Educational Multi-Media for Mathematics and Science Tutors.**
Des Moines Area Community Coll., Ankeny, Iowa.
Pub Date Feb 72
Note—217p.
**EDRS Price MF-$0.65 HC-$9.87**
Descriptors—Activities, *Audiovisual Aids, *Elementary School Mathematics, *Elementary School Science, Handicapped Students, Instruction, Instructional Materials, *Instructional Media, Learning Activities, *Tutoring
In the belief that uses of many different media will help motivate students, this book was compiled to assist tutors, particularly in science and mathematics, in using multi-media. Special emphasis was placed on increasing the tutor's understanding of mathematics and science. Following a chapter on the history and development of instructional technology, classroom media equipment (such as films, filmstrips, transparencies, pictures, tapes, etc.) is described with its advantages and disadvantages and instructions on determining appropriate usage. Some simple techniques for using media are outlined, including uses for easily obtained household items. Two chapters cover some elementary mathematics and science concepts and the applications of media to tutoring in these areas. A section on the handicapped child and adaptation of media to his situation is also included. The final chapter comments on the tutor's role, and sources of free and inexpensive materials are listed with the bibliographies. While the subject matter is generally from the elementary level, the discussions about the media are intended for all levels. (JM)

ED 064 177 SE 014 219
*Shoemaker, Terry Swadener, Marc*
**Ideas for Manipulative Materials—Elementary Mathematics Concepts.**
Northern Colorado Educational Board of Cooperative Services, Boulder.
Pub Date 72
Note—55p.
Available from—ERIC/SMEAC, 1460 West Lane Avenue, Columbus, Ohio 43221 (on loan)
**Document Not Available from EDRS.**
Descriptors—*Activities, *Elementary School Mathematics, Geometry, *Instructional Materials, *Manipulative Materials, Number Concepts, Resource Materials, Set Theory
This is a set of 8 x 11-inch cards containing ideas for manipulative materials, generally inexpensive household items, for use in the elementary classroom. The cards are tab-indexed into seven categories: sets (which is subdivided into set recognition and set operations), number-numerals, geometry, measurement, probability, number theory, and function. Each card states objectives, the supplies needed, and suggested activities. The activities described are flexible in nature, and possible additional activities are suggested. (JM)

Manipulative Materials

Objective-Item Bank

ED 066 494 TM 001 978
*Lieberman, Marcus And Others*
**Primary Mathematics: Behavioral Objectives and Test Items.**
Institute for Educational Research, Downers Grove, Ill.
Pub Date 72
Note—173p.
Available from—Institute for Educational Research, 1400 West Maple Avenue, Downers Grove, Illinois 60515 ($4.00)
**EDRS Price MF-$0.65 HC-$6.58**
Descriptors—*Behavioral Objectives, Curriculum Development, *Individualized Instruction, *Item Banks, *Mathematics, *Primary Grades, Program Evaluation
Identifiers—ESEA Title III, *Evaluation for Individualized Instruction Project
The Objective-Item Bank presented covers 16 sections of four subject areas in each of four grade levels. The four areas are: Language Arts, Math, Social Studies, and Science. The four grade levels are: Primary, Intermediate, Junior High, and High School. The Objective-Item Bank provides school administrators with an initial starting point for curriculum development and with the instrumentation for program evaluation, and offers a mechanism to assist teachers in stating more specifically the goals of their instructional program. In addition, it provides the means to determine the extent to which the objectives are accomplished. This document presents the Objective Item Bank for primary mathematics. (CK)

College Mathematics

ED 066 311 SE 014 455
**Suggestions on the Teaching of College Mathematics.**
Mathematical Association of America, Berkeley, Calif. Committee on the Undergraduate Program in Mathematics.
Pub Date Jan 72
Note—39p.
Available from—CUPM, P. O. Box 1024, Berkeley, California 94701
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*College Mathematics, *Course Organization, Effective Teaching, *Instruction, *Mathematics Education, Teacher Education, Teaching Methods, Teaching Quality
Identifiers—CUPM
This handbook on effective college mathematics teaching offers suggestions on course planning; lecturing; using the blackboard, textbooks, and visual aids; making assignments; scheduling, composing, and grading tests; and giving grades. It also discusses feedback and instructor evaluation and includes a sample questionnaire that might be given to students. A section on the role of teaching assistants suggests that a program of regular visitation, evaluation, orientation, and guidance by regular faculty members be followed. The final section lists professional journals and periodicals concerned with higher education, and gives a bibliography of books on mathematics, mathematics history, and mathematics teaching. (DT)

Computers

ED 064 136 SE 013 880
**Recommendations Regarding Computers in High School Education.**
Conference Board of the Mathematical Sciences, Washington, D.C.
Spons Agency—National Science Foundation, Washington, D.C.
Pub Date Apr 72
Note—36p.
Available from—Conference Board of the Mathematical Sciences, 2100 Pennsylvania Avenue, N.W., Suite 834, Washington, D.C. 20037
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Computer Oriented Programs, *Computer Science Education, *Curriculum Development, Educational Technology, *Mathematics Education, Secondary Education, *Secondary School Mathematics, Teacher Education, Vocational Education
Identifiers—National Science Foundation
Recommendations include: (1) the development of a computer-literacy course at the junior-high level to inform students about the nature of computers and their impact on daily life; (2) the development of an independent follow-up course designed to develop proficiency in the use of computers; (3) the development of short modules emphasizing the application of mathematics to relevant problems and leading to the development of algorithms, with suggested examples; (4) the development of modules for use in fields other than mathematics, with suggested examples; (5) the development of special programs for the gifted student; (6) increased effort toward vocational computer training and the development of a learner's language related to COBOL; (7) that the National Science Foundation support development of programs for training teachers; and (8) that a national clearinghouse be established for information on computer activities and education in the schools. (JM)

The other three documents in the set are:

ED 066 495 TM 001 979
Lieberman, Marcus And Others
**Intermediate Mathematics: Behavioral Objectives and Test Items.**
Institute price, $13.00;
EDRS price, MF-$0.65,
HC-$19.74 (587 p.)

ED 066 496 TM 001 980
Lieberman, Marcus And Others
**Junior High Mathematics: Behavioral Objectives and Test Items.**
Institute price, $7.00;
EDRS price, MF-$0.65,
HC-$9.87 (236 p.)

ED 066 497 TM 001 981
Lieberman, Marcus And Others
**High School Mathematics: Behavioral Objectives and Test Items.**
Institute price, $16.00;
EDRS price, MF-$0.65,
HC-$29.61 (810 p.)

Laboratories

ED 066 315 24 SE 014 466
*Hollis, Loye Y.*
**A Study of the Effect of Mathematics Laboratories on the Mathematical Achievement and Attitude of Elementary School Students. Final Report.**
Spons Agency—National Center for Educational Research and Development (DHEW/OE), Washington, D.C.
Bureau No—BR-9-G-038
Pub Date Jul 72
Grant—OEG-7-9-530038-0125
Note—24p.
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Academic Achievement, *Activity Learning, *Attitudes, *Elementary School Mathematics, High Achievers, Intermediate Grades, Laboratories, Low Achievers, Manipulative Materials, *Research
The study attempted to determine the extent to which a mathematics laboratory would enable both slow and gifted learners to gain in achievement in mathematics and to develop more positive attitudes toward mathematics. On the basis of ability, achievement in school, and results on the California Achievement Test, 75 fourth, fifth, and sixth grade students from each of two schools were selected as the research group, and 75 in one school and 40 in another were identified as the control group. Two mathematics laboratories in two elementary schools were put into operation and students attended 45-minute laboratory sessions twice weekly. Sessions were conducted on a diagnose-prescribe model, focusing on the areas where students needed additional work. Posttests for achievement and attitude were administered when the laboratory sessions concluded. The study found that mathematics laboratories used with slow learners and with gifted learners facilitated a slightly increased academic achievement in both cases, with more of an increase occurring at the lower grade levels. The laboratories also facilitated an increased positive attitude toward mathematics, with a significant increase occurring in the school located in a deprived area. There was no significant difference in achievement scores between laboratory and control groups. (Author/DT)

Curriculum Construction

ED 064 163 SE 014 165
*Heimer, Ralph T And Others*
**A Study of Paradigms for the Construction and Evaluation of CAI Curricular Materials in Mathematics. Volume I: Philosophical Studies. Final Report.**
Pennsylvania State Univ., University Park.
Spons Agency—National Science Foundation, Washington, D.C.
Report No—NSF-GJ-102
Pub Date Dec 71
Note—101p.
**EDRS Price MF-$0.65 HC-$4.58**
Descriptors—*Computer Assisted Instruction, Computer Oriented Programs, *Curriculum, *Educational Philosophy, Instruction, *Mathematics Education
Identifiers—*Paradigms
This is the first of a three-volume report on a National Science Foundation project called PARADIGMS. An overview of the PARADIGMS project, an analysis of the concept paradigm, and objectives of the project are presented in the first section. The next two sections cover some specific paradigms for research and action, including sample CAI curricular segments. The epilogue summarizes goals, activities, and products of the project and implications of the project regarding research and development within the curricular/instructional domain. (JM)

Project Report

ED 065 315 24 SE 014 287
*Marshall, J. Laird Fischbach, Thomas J.*
**Evaluation of Patterns in Arithmetic in Grades 1-4, 1970-71: Effects on Teachers.**
Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
Spons Agency—National Center for Educational Research and Development (DHEW/OE), Washington, D.C.
Report No—TR-225
Bureau No—BR-5-0216
Pub Date Mar 72
Contract—OEC-5-10-154
Note—93p.
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—Arithmetic, *Curriculum Development, *Elementary School Mathematics, Inservice Programs, *Instruction, *Research, Teacher Attitudes, *Teacher Education, Televised Instruction
A large-scale, summative, comparative evaluation of "Patterns in Arithmetic (PIA)", a modern televised arithmetic curriculum for grades one through six, was carried out in grades one through four in both rural and urban schools during the 1970-71 school year. This report deals with the ways in which PIA affects teachers: in basic mathematical knowledge, knowledge of PIA-specific content, and attitudes toward teaching arithmetic. Findings indicate that PIA can be used effectively as in-service education, particularly for those teachers with relatively lower initial knowledge of the basic mathematics which underlies a contemporary elementary school mathematics program. PIA does not seem to change teachers' attitudes, however, nor is it beneficial in increasing knowledge of concepts not specifically related to PIA. These results seem to hold equally for both rural and urban schools. (Author/JM)

Theory

ED 065 344 SE 014 420
*Adler, Marilynne*
**Some Implications of the Theories of Jean Piaget and J. S. Bruner for Education.**
Toronto Board of Education (Ontario). Research Dept.
Pub Date [63]
Note—45p.
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Educational Theories, *Elementary School Mathematics, *Instruction, Instructional Materials, *Learning, Mathematics Education, Number Concepts
Identifiers—Bruner (Jerome), Piaget (Jean)
This paper examines the research and theories of Piaget and Bruner and some implications for education, particularly as applied to mathematics education in the elementary grades. Piaget's theories are divided into the general development and conceptual thinking and mathematical concepts in children. Experimental evidence is cited and a short section on structural materials for the mathematics classroom follows. A brief summary ties the two men's beliefs together with respect to readiness, curriculum, and structural materials. (JM)

Geometry

ED 064 148 24 SE 014 127
*Steiner, Hans-Georg, Ed.*
**The Teaching of Geometry at the Pre-College Level.**
Central Midwestern Regional Educational Lab., St. Ann, Mo.
Spons Agency—National Center for Educational Research and Development (DHEW/OE), Washington, D.C.
Bureau No—BR-6-2875
Pub Date 71
Note—387p.; Proceedings of the second CSMP International Conference
Available from—CEMREL, 10646 St. Charles Rock Road, St. Ann, Missouri 63074 ($10.00)
**Document Not Available from EDRS.**
Descriptors—Algebra, *Conference Reports, Educational Objectives, Educational Problems, *Geometry, *Mathematics, *Mathematics Education, *Secondary School Mathematics, Topology
This is a collection of 24 papers presented or prepared by participants of the Comprehensive School Mathematics Program (CSMP) International Conference in 1970 covering a wide range of topics in mathematics and geometry education. Conference recommendations are summarized, including the use of geometry to lead into other branches of mathematics and to teach conceptual model building, abstention from using geometry primarily to teach logic, and improvement in teacher training courses. The papers are both mathematical and educational in emphasis covering mathematical topics such as polygons, topology, geometric algebra, conics, inversive geometry, Euclidean geometry, and axiomatics. Educational topics include the relevance of geometry at the secondary level and problems in modern mathematics education, with suggestions for new approaches, particularly with respect to geometry. (JM)

Objectives

ED 059 900 SE 013 400
*Walbesser, Henry H. Eisenberg, Theodore A.*
**A Review of Research on Behavioral Objectives and Learning Hierarchies.**
ERIC Information Analysis Center for Science Education, Columbus, Ohio.
Pub Date Jan 72
Note—82p.
Available from—Ohio State University, Center for Science and Mathematics Education, 248 Arps Hall, Columbus, Ohio 43210 ($1.25 plus $.25 handling)
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Behavioral Objectives, Instruction, *Learning, *Mathematics Education, Psychometrics, *Research Reviews (Publications), *Science Education
Identifiers—Learning Hierarchies
In the first part of this paper, the purposes of behavioral objectives are outlined; research is then summarized, including the influence of knowledge of the behavioral objectives on a learner's performance, teacher recognition of behavioral objectives and student attitudes to behavioral objectives. The second part presents a summary of methods of constructing learning hierarchies. The research topics outlined include the structure and efficiency of expert versus student generated hierarchies, relationships between performances on adjacent levels of a hierarchy, and the psychometrics of learning hierarchies. Each part of this paper contains a table of the research hypotheses investigated, with a listing of supporting and non-supporting experiments reported. Although most of the research reviewed refers to mathematics and science, studies in other areas are also included. (MM)

Research

ED 064 175 SE 014 193
*Begle, Edward G.*
**Teacher Knowledge and Student Achievement in Algebra, School Mathematics Study Group Reports Number 9.**
Stanford Univ., Calif. School Mathematics Study Group.
Spons Agency—National Science Foundation, Washington, D.C.
Report No—SMSG-R-9
Pub Date 72
Note—109p.
**EDRS Price MF-$0.65 HC-$6.58**
Descriptors—*Achievement, *Algebra, Mathematics Teachers, *Research, *Secondary School Mathematics, Teacher Characteristics, *Teacher Influence
This study investigated the relationship between algebraic understanding of teachers and student achievement in algebra in one academic year. Pretests to measure teachers' understanding of modern algebra and the algebra of the real number system, student pretests to enable consideration of individual differences, and posttests to measure student achievement were developed and administered. The final analysis involved 308 teachers of ninth grade first-year algebra students. No educationally significant correlations between teacher understanding of algebra and student achievement were found. Recommendations include more and broader studies and the use of teachers' willingness to examine their own classroom effectiveness. Tests and statistics are included. (JM)

# News Notes

### Cognitive Psychology and the Mathematics Laboratory

A symposium on "Cognitive Psychology and the Mathematics Laboratory" was held at Northwestern University on February 15-16. A coordinated series of lectures was given by Robert Davis, Max Bell, John LeBlanc, Zoltan Dienes, Charles Smock, Leslie Steffe, and Barry Beilin. ERIC/SMEAC will be publishing the papers from this conference; the next newsletter will contain information on how to order this document.

### National Assessment: Mathematics

The National Assessment of Educational Progress (NAEP) is now conducting the mathematics assessment. Administration of the exercises began in October and will continue in selected schools across the country until July. Reporting of results is scheduled for December 1974. The exercises were developed by NAEP staff, the Psychological Corporation, and mathematics educators, and include manipulative materials and visuals. A computer task and consumer mathematics exercises are among those included for older students. To have your name placed on the mailing list for the NAEP "Newsletter," write: NAEP Newsletter, Education Commission of the States, 1860 Lincoln Street, Denver, Colorado 80203.

### Undergraduate Mathematics Conference

In the summer of 1971, the University of Missouri-Rolla held a conference for college teachers on applications of undergraduate mathematics. Support for the conference was received from the National Science Foundation. Applications of calculus, linear algebra, differential equations, and probability were discussed. The CUPM Central Office has edited the proceedings; to receive your copy, send $3.50 ($3.68 for California residents) to: CUPM, Box 1024, Berkeley, California 94701. Only prepaid orders can be accepted.

### American Educational Research Association

The Annual Meeting of the American Educational Research Association (AERA) was held in New Orleans on February 26-March 1. Several sessions on mathematics education were scheduled, including an invited address by Merle C. Wittrock, University of California at Los Angeles, on "Recent Research in Cognition and Mathematics Learning," sponsored by the Special Interest Group for Research in Mathematics Education (SIG/RME). This address will be published by ERIC/SMEAC; the next newsletter will contain information on how to order this. SIG/RME also sponsored two presessions on research prior to the annual meeting: "Computational Algorithms: Developing a Coordinated Set of Studies," and "Reasoning and Logical Thinking."

### Interdisciplinary Meeting on Structural Learning

The Structural Learning and Mathematics Education (MERG) Groups have announced the Fourth Annual Interdisciplinary Meeting on Structural Learning, to be held at the University of Pennsylvania on April 6-7, 1973. Theoretical and empirical research will be given equal emphasis. The Structural Learning Group and the Jean Piaget Society will co-sponsor an invited talk. For further information on the meeting, contact: Dr. Joseph M. Scandura, Graduate School of Education, University of Pennsylvania, Philadelphia, Pennsylvania 19104.

### National Council of Teachers of Mathematics

The Annual Meeting of the National Council of Teachers of Mathematics will be held in Houston on April 25-28. Morris Kline, New York University, will speak at the opening session on "The Principles of a Desirable Curriculum Reform." Giving the banquet address will be John Furbay, author and lecturer, with the topic, "Revolution: Which One?" Workshops and section meetings are planned for teachers at all levels.

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**Available soon from ERIC/SMEAC:**

**Research in Mathematics Education Reported in 1972** by Marilyn N. Suydam and J. Fred Weaver—an annotated listing of published research and dissertation abstracts.

**Use of Computers in Mathematics Education** Resource Series—a set of papers and bibliographies.

See the next newsletter for further details!

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ADDRESS CORRECTION REQUESTED

ERIC Information Analysis Center
for Science, Mathematics, and
Environmental Education
400 Lincoln Tower
The Ohio State University
Columbus, Ohio 43210

# We've Moved!

ERIC/SMEAC is still in Columbus—but as of March 1, 1973 our new address is on the campus of The Ohio State University:

ERIC Information Analysis Center for
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400 Lincoln Tower
The Ohio State University
Columbus, Ohio 43210

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# SMEAC

**ERIC**

## Where Are the Collections of ERIC Documents?

Also: Alaska, 1
Hawaii, 2
Puerto Rico, 3
Canada, 26
Others, 13

**Research in Education** and **Current Index to Journals in Education** are (or should be!) in most large libraries. Often you can ascertain whether or not to order a document from the information provided by the descriptors and annotation for each document you've located in a search of **RIE** and/or **CIJE**. Sometimes, however, you can't be sure—or you want to scan the document but not buy it. You need a copy of the document.

Complete files of ERIC documents are located in centers scattered across the United States. The map will help you to approximate the site of the ERIC collection nearest to you. If you want a list of locations in your state, please write to us.

SE 017 936

# CENTER CLIPPINGS...

These documents are some of those announced in Research in Education during January, February, or March 1973.

**ED 068 315** SE 014 717

*Barczyk, Gloria J.*

**A Teacher's Approach to Adjusting Instruction in Elementary School Mathematics to Varied Ability Groups.**

Pub Date [71]

Note—78p.

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—Behavioral Objectives, *Curriculum, Curriculum Guides, Elementary Grades, *Elementary School Mathematics, Grade 5, *Individualized Instruction, Instruction, *Instructional Materials, Lesson Plans, Mathematics Education, *Teacher Developed Materials, Worksheets

Identifiers—Systems Approach to Mathematics Instruction (SAM)

This paper is concerned with developing a mathematics curriculum for the fifth grade which uses a program of varied difficulty of instruction based on "A Systems Approach to Improving Mathematics Instruction" (SAM), a program developed in the Pittsburgh area. The first portion of the paper is a general discussion of facets involved in curriculum construction. The remainder of the paper details the specific objectives, the selecting and sequencing of content, and the instructional organization of a fifth grade mathematics course. Sample materials are included: a "Curriculum Suggested Pace" which lists the basic levels of instruction as well as suggested enrichment topics for each level; behavioral objectives for each basic level; and the complete lesson plans along with teacher-constructed materials for two of the topics covered in the curriculum (fractions and negative numbers). (DT)

**ED 067 397** TM 001 792

*Williams, S. Irene Jones, Chancey O.*

**A Comparison of Interview and Normative Analysis of Mathematics Questions.**

Educational Testing Service, Princeton, N.J.

Spons Agency—College Entrance Examination Board, New York, N.Y.

Report No—TDR-71-4

Pub Date Apr 72

Note—49p.

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—*College Entrance Examinations, Evaluation Methods, Interviews, *Item Analysis, Problem Solving, *Question Answer Interviews, Research Methodology, *Secondary School Mathematics, Student Participation, Test Construction, Test Results, *Tests

Identifiers—*College Board Mathematics Level 2

Answers to the following questions were sought in this study: (1) Does the interview technique provide information that cannot be obtained from the usual normative approach?; (2) Does the interview technique provide information leading to the revision of mathematics test questions? Are the revised questions better than the original version in specified ways?; and (3) Does the interview technique provide information about the extent to which the student has been exposed in a mathematics course to the topic, concept, or skill that is central to the correct solution of a particular question? The College Board Mathematics Level II pretest was administered to 10 students in a senior mathematics course, to 30 juniors in a mathematics honors course, and to 35 juniors and seniors in mathematics courses. Fifteen selected students were then interviewed as to their methods of problem solution. The original pretest was then administered to the pretest population, and a pretest consisting of 16 questions identical to those in the original pretest and 9 questions that were revisions was also administered. Results of the study show that the answer to question (1) above was "yes"; in answer to question (2), nine questions in the pretest (items 2, 10, 14, 18, 20, 21, 23, and 24) were revised; and the answer to question (3) was a definite "yes." Appendixes provide the Item Interview Record and Test Interview Record, Procedures Used in Carrying Out the Study, Score Distributions for Total Group and Interview Group, Item Analysis for Total Group, Item Analysis for Interview and Pretest Groups and Interview Results for Each Item and Graphs. (DB)

**ED 069 496** 24 SE 015 142

*Lankford, Francis G., Jr.*

**Some Computational Strategies of Seventh Grade Pupils. Final Report.**

Virginia Univ., Charlottesville. School of Education.

Spons Agency—National Center for Educational Research and Development (DHEW/OE), Washington, D.C.

Bureau No—BR-2-C-013

Pub Date Oct 72

Grant—OEG-3-72-0035

Note—96p.

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—*Algorithms, Fractions, Grade 7, Learning, *Mathematics Education, *Research, Secondary School Mathematics, Whole Numbers

Identifiers—*Computation, Diagnostic Interviews

One hundred seventy-six seventh grade students underwent a recorded interview where each was given a set of computational exercises and asked to say aloud his thinking as he worked them. The most frequently used strategies in computations with whole numbers and fractions are described in detail, an analysis of the nature of wrong answers is included, and characteristics of good and poor computers are listed and discussed. Thirteen conclusions are given, covering computational strategies, vertical vs. horizontal problem arrangement, mathematical vocabulary of students, estimating answers, and the technique of using recorded interviews in research. The computation problems given to the students are included in the report, and the appendices list all the wrong answers given with the accompanying verbal description by the student. (DT)

**ED 069 525** SE 015 336

*Choate, Stuart A.*

**Activities with Ratio and Proportion.**

Oakland County Schools, Pontiac, Mich.

Spons Agency—Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.

Pub Date Sep 70

Grant—OEG-68-05635-0

Note—135p.; Revised Edition

**EDRS Price MF-$0.65 HC-$6.58**

Descriptors—Curriculum, Instruction, *Instructional Materials, Low Ability Students, Mathematics Education, Objectives, *Percentage, *Ratios (Mathematics), *Secondary School Mathematics, Units of Study (Subject Fields), Worksheets

Identifiers—ESEA Title III

This instructional unit focuses on writing ratios and proportions in problem situations, solutions by means of proportions, and determination of percentages. A number of experiments are suggested and worksheets and discussion questions are included. The activities are oriented toward situations in which the students would probably have had some previous experience. A teacher's guide is also available. Related documents are SE 015 334, SE 015 335, and SE 015 337 through SE 015 347. This work was prepared under an ESEA Title III contract. (LS)

**ED 069 469** SE 014 567

**Basic Mathematics Machine Calculator Course.**

Windsor Public Schools, Conn.

Pub Date 69

Note—533p.

**EDRS Price MF-$0.65 HC-$19.74**

Descriptors—*Algorithms, Grade 10, Instruction, *Instructional Materials, Laboratory Procedures, Mathematical Applications, Mathematics Materials, Practical Mathematics, Problem Solving, *Secondary School Mathematics, *Workbooks

Identifiers—Desk Calculators, *General Mathematics

This series of four text-workbooks was designed for tenth grade mathematics students who have exhibited lack of problem-solving skills. Electric desk calculators are to be used with the text. In the first five chapters of the series, students learn how to use the machine while reviewing basic operations with whole numbers, decimals, fractions, and percents. The rest of the chapters present word problems in simple consumer mathematics, business activities, installment buying, banking, stocks and bonds, insurance, taxes, and utilities. A chapter on the use of formulas is included. (DT)

# "Mini-bib": Mathematics Laboratories

Since we have received a number of requests on some topics, we have decided to include lists of references for such topics in issues of this Newsletter. These will be in the form of a "mini-bibliography:" a short, selected list of pertinent documents. Some of the documents in this "mini-bib" on mathematics laboratories were located through a search in **Research in Education** and **Current Index to Journals in Education,** using such descriptors as "Laboratories," "Laboratory Procedures," and "Activity Learning," and cross-checking to include only references which also have mathematical descriptors. (For those who want to do a more thorough search, descriptors such as "Manipulative Materials" and "Instructional Materials" should also be considered: these will provide information on many materials which might be useful in a mathematics laboratory situation.)


Barson, Alan. The Mathematics Laboratory for the Elementary and Middle School. **Arithmetic Teacher** 18: 565-567; December 1971.

Bernard, Richard Paul. The Historical Development of the Laboratory Approach to Elementary School Mathematics. (Indiana University, 1972.) **Dissertation Abstracts International** 33A: 5028; March 1973.

Beuthel, Donald G. and Meyer, Phyllis I. A Regular Classroom Plus a Mathematics Laboratory. **Arithmetic Teacher** 19: 527-530; November 1972.

Boucher, Jim. New Mathematics in the Primary School. **Mathematics in School** 1: 10-12; March 1972.

Brousseau, Andre R. Mathematics Laboratories: Should We or Should We Not? **School Science and Mathematics** 73: 99-105; February 1973.

Brydegaard, Marguerite and Inskeep, James E., Jr. **Mathematical Experiencing.** Washington: American Association of Elementary, Kindergarten, and Nursery Educators, 1972. (ERIC: ED 062 168. Available only on microfiche from EDRS.)

Cohen, Martin Seymour. A Comparison of Effects of Laboratory and Conventional Mathematics Teaching Upon Underachieving Middle School Boys. (Temple University, 1970.) **Dissertation Abstracts International** 31A: 5026-5027; April 1971.

Deans, Edwina. The Laboratory Approach to Elementary Mathematics. **Today's Education** 60: 20-22; February 1971.

Dittmer, Karen Ann. Guidelines for Developing a Mathematics Laboratory. (University of Alabama, 1971.) **Dissertation Abstracts International** 32A: 5083-5084; March 1972.

Ewbank, William A. The Mathematics Laboratory: What? Why? When? How? **Arithmetic Teacher** 18: 559-564; December 1971.

Ferrell, Phyllis C. **A Developmental Program to Non-Grade Mathematics K-12.** Arlington Heights, Illinois: Elk Grove Training and Development Center, June 1969. (ERIC: ED 037 336; 105 p.)

Finnell, Clyde Allen. A Laboratory Mathematics Approach: An Evaluation of Cognitive and Affective Learning in Ninth Grade Mathematics Classes in the United States Dependents Schools, European Area. (University of Southern California, 1972.) **Dissertation Abstracts International** 33A: 4053-4054; February 1973.

Fitzgerald, William M. **About Mathematics Laboratories.** East Lansing: Michigan State University, 1972. (ERIC: ED 056 895, 33 p.)

Greenes, Carole E.; Willcutt, Robert E.; and Spikell, Mark A. **Problem Solving in the Mathematics Laboratory:** How To Do It. Boston: Prindle, Weber & Schmidt, Inc., 1972.

Higgins, Jon L. **The Mathematics Through Science Study: Attitude Changes in a Mathematics Laboratory.** SMSG Reports, No. 8. Stanford: Stanford University, 1969. (ERIC: ED 064 174; 64 p.)

Higgins, Jon L. Attitude Changes in a Mathematics Laboratory Utilizing a Mathematics-Through-Science Approach. **Journal for Research in Mathematics Education** 1: 43-56; January 1970.

Hollis, Loye Y. **A Study of the Effect of Mathematics Laboratories on the Mathematical Achievement and Attitude of Elementary School Students.** Final Report, National Center for Educational Research and Development, July 1972. (ERIC: ED 066 315; 24 p.)

Howard, Vivian Gordon. Teaching Mathematics to the Culturally Deprived and Academically Retarded Rural Child. (University of Virginia, 1969.) **Dissertation Abstracts International** 31A: 294-295; July 1970.

Johnson, Randall Erland. The Effect of Activity Oriented Lessons on the Achievement and Attitudes of Seventh Grade Students in Mathematics. (University of Minnesota, 1970.) **Dissertation Abstracts International** 32A: 305; July 1971.

Kidd, Kenneth P.; Myers, Shirley S.; and Cilley, David M. **The Laboratory Approach to Mathematics.** Chicago: Science Research Associates, Inc., 1970.

Kieren, Thomas E. Activity Learning. **Review of Educational Research** 39: 509-522; October 1969.

Kieren, Thomas E. Manipulative Activity in Mathematics Learning. **Journal for Research in Mathematics Education** 2: 228-234; May 1971.

Krulik, Stephen. **A Mathematics Laboratory Handbook for Secondary Schools** Philadelphia: W. B. Saunders Co., 1972. (ERIC: ED 059 061; document not available from EDRS.)

Matthews, Geoffrey and Comber, Julia. Mathematics Laboratories. **Arithmetic Teacher** 18: 547-550; December 1971.

May, Lola J. Math Lab. **Grade Teacher** 89: 103-105, 167; September 1971. 89: 64-66; October 1971. 89: 44-45, 71; November 1971.

McClure, Clair Wylie. Effectiveness of Mathematics Laboratories for Eighth Graders. (The Ohio State University, 1971.) **Dissertation Abstracts International** 32B: 4078; January 1972.

Miller, George R. The Use of Formative Evaluation Procedures in the Development of a Mathematics Laboratory. Paper presented at the Annual Meeting of the American Educational Research Association, 1972. (ERIC: ED 063 341; 25 p.)

Nowak, Betty Adams. A Study to Compare the Effects of Mathematics Laboratory Experiences of Intermediate-Grade Students on Achievement and Attitudes. (Brigham Young University, 1972.) **Dissertation Abstracts International** 33A: 2697; December 1972.

Osborne, Alan R. Lab Oratory and the Generalization Gap. **Arithmetic Teacher** 18: 545-546; December 1971.

Porteus, D. R. Activity-Centered Learning in a Mathematics Laboratory. **Australian Mathematics Teacher** 28: 5-11; March 1972.

Reys, Robert E. and Post, Thomas R. **The Mathematics Laboratory; Theory to Practice.** Boston: Prindle, Weber & Schmidt, Inc., 1973.

Ropes, George Hardcastle. The Effects of a Mathematics Laboratory on Elementary School Students. (Columbia University, 1972.) **Dissertation Abstracts International** 33A: 4250; February 1973.

Schippert, Frederick Arthur. A Comparative Study of Two Methods of Arithmetic Instruction in an Inner-City Junior High School. (Wayne State University, 1964.) **Dissertation Abstracts** 25: 5162-5163; March 1965.

Silbaugh, Charlotte Vance. A Study of the Effectiveness of a Multiple-Activities Laboratory in the Teaching of Seventh Grade Mathematics to Inner-City Students. (The George Washington University, 1972.) **Dissertation Abstracts International** 33A: 205; July 1972.

Vance, James H. The Effects of a Mathematics Laboratory Program in Grades 7 and 8—An Experimental Study. Unpublished doctoral Dissertation, University of Alberta, 1969.

Vance, James H. and Kieren, Thomas E. Laboratory Settings in Mathematics: What Does Research Say to the Teacher? **Arithmetic Teacher** 18: 585-589; December 1971.

Vance, James H. and Kieren, Thomas E. Mathematics Laboratories—More than Fun? **School Science and Mathematics** 72: 617-623; October 1972.

Whipple, Robert M. A. Statistical Comparison of the Effectiveness of Teaching Metric Geometry by the Laboratory and Individualized Instruction Approaches. (Northwestern University, 1972.) **Dissertation Abstracts International** 33A: 2699-2700; December 1972.

Wilkinson, Jack Dale. A Laboratory Method to Teach Geometry in Selected Sixth Grade Mathematics Classes. (Iowa State University, 1970.) **Dissertation Abstracts International** 31A: 4637; March 1971.

Wilson, Lois Fair. **The Discovery Approach to Mathematics.** February 1971. (ERIC: ED 059 089; 45 p.)

(No author cited.) **The Secondary Mathematics Laboratory Strategy Manual.** Titusville, Florida: Brevard County Board of Public Instruction, June 1970. (ERIC ED 048 143; 58 p.)

# News Notes

**Plan Ahead . . .**

A session on "Have You Met ERIC?" is scheduled for the NCTM Name-of-Site Meeting in Fort Worth, August 15-17, 1973. Marilyn N. Suydam will provide this introduction. A workshop on the use of ERIC is scheduled for the NCTM Name-of-Site Meeting in Atlanta, Georgia, October 25-27, 1973. Jon L. Higgins and F. Joe Crosswhite of ERIC/SMEAC will conduct this session, designed to teach the specifics of using the ERIC system. At other meetings look for the ERIC booth in the materials display. It made its first appearance at the NCTM Annual Meeting in Houston, April 25-28, 1973.

**In the Meantime . . .**

An article by Jon L. Higgins in the March 1973 issue of **The Arithmetic Teacher** will give you a good start in learning more about ERIC. It's titled, "How Thirty Measuring Sticks, Twenty-nine Kids, and I Started Using Research in the Classroom." Hope you enjoy reading it!

**MicroLibraries of ERIC Mathematics Education Documents Available**

Basic collections of ERIC mathematics education documents in microfiche format will soon be available from Microfiche Systems Corporation. Selected in cooperation with ERIC/SMEAC, the collections will contain full-text documents announced in **Research in Education** between 1966 and 1972. The Elementary collection will contain 450 documents; the Secondary collection, 500 documents; and the Higher Education collection, 400 documents. A tri-level combined collection will also be offered. Similar MicroLibraries for science education and environmental education will also be available.

Prices and ordering information for MicroLibraries may be obtained by writing: Microfiche Publications Division, Microfiche Systems Corporation, 305 East 46th Street, New York, New York 10017.

**Compilations of Mathematics Education Document Abstracts Available**

A collection of abstracts of mathematics education documents that have appeared in **Research in Education** from 1966-1972 will soon be available from Education Associates, Inc. Developed in cooperation with ERIC/SMEAC, the compilation will feature subject and author indexes similar to those found in RIE. The compilation will enable users to conduct rapid manual searches of a data base of over 2000 ERIC mathematics education documents. Similar compilations for science education and environmental education document abstracts will also be available.

Prices and ordering information for the three compilations may be obtained by writing: Education Associates, Inc., P. O. Box 441, Worthington, Ohio 43085.

**Price Increases . . .**

Changes in the prices of subscriptions to **Research in Education** and **Current Index to Journals in Education** have been announced. **Research in Education** (12 issues per year) is now $38, domestic; $47.50; foreign. Single copies are $3.25 each. (The address for **RIE** is: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.) **Current Index to Journals in Education** (12 issues per year) is now $44, domestic; semi-annual and annual cumulative indexes, $45. Single copies are $3.50. Foreign subscriptions have postage added. (The address for **CIJE** is: CCM Information Corporation, 866 Third Avenue, New York, New York 10022.)

**This One is Still Free!**

We hope you realize that this Newsletter is still free! If you know of someone whose name is not on our mathematics education newsletter mailing list, please send us the name and address (including zip code).

If you have any announcements which would interest our readers, please send them, too. We'll include them whenever possible. (Please direct them ATTN: Marilyn N. Suydam.)

# Metrication: Be Prepared!

While Congress has not yet passed the final bill on metrication, teachers are among those anticipating the change in our system of measurement. To help you prepare, here are some pertinent documents and references.

Documents listed in **Research in Education** include the following:

DeSimone, Daniel V. **A Metric America: A Decision Whose Time Has Come.** Washington: National Bureau of Standards, July 1971. (ERIC: ED 055 884; 192 p. Also available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; Catalog No. C 13.10/345, $2.25.)
This report evaluates and distills the findings of the United States Metric Study in which thousands of individuals, firms, and organized groups representative of our society participated.
Related reports on the Metric Study are:
ED 055 890 **U.S. Metric Study Interim Report: Education.** (210 p. Also available from GPO; Catalog No. C 13.10/345-6, $1.75.)
ED 065 340 **U.S. Metric Study Interim Report: Federal Government: Civilian Agencies.** (325 p. Also available from GPO; Catalog No. C 13.10/345-2, $2.25.)
ED 065 341 **U.S. Metric Study Interim Report: Nonmanufacturing Businesses.** (192 p. Also available from GPO; Catalog No. C 13.10/345-5, $1.50.)
ED 065 342 **U.S. Metric Study Interim Report: The Consumer.** (147 p. Also available from GPO; Catalog No. C 13.10/345-7, $1.25.)
ED 065 343 **U.S. Metric Study Interim Report: Testimony of Nationally Representative Groups.** (175 p. Also available from GPO; Catalog No. C 13.10/345-12, $1.50.)
ED 068 326 **U.S. Metric Study Interim Report: A History of the Metric System Controversy in the United States.** (308 p. Also available from GPO; Catalog No. C 13.10/345-10, $2.25. [Also cited as ED 069 885.])

Lighthill, M. J. and Others. Metric Units in Primary Schools. London: Royal Society, April 1970. (ERIC: ED 052 992; document not available from EDRS.) Although this pamphlet is intended as background material for teachers in English primary schools, the educational implications of the change and the lists of apparatus suitable for use with children up to 14 years of age are sufficiently general for use in other countries introducing the metric system.

The April 1973 issue of **The Arithmetic Teacher** is devoted to articles on metrication. Included are:

Hallerberg, Arthur E. The Metric System: Past, Present—Future? (pages 247-255)
King, Irv and Whitman, Nancy. Going Metric in Hawaii. (pages 258-260)
Williams, Elizabeth. Metrication in Britain. (pages 261-264)
Helgren, Fred J. Schools Are Going Metric. (pages 265-267)
Viets, Lottie. Experiences for Metric Missionaries. (pages 269-273)
Vervoort. Inching Our Way Towards the Metric System. (pages 275-279) (Also in the April 1973 issue of **The Mathematics Teacher,** pages 297-302)
Immerzeel, George and Wiederanders, Don. IDEAS. (pages 280-287)

The May 1973 issue of **The Arithmetic Teacher** contains additional articles on metrication.

Other articles cited in **Current Index to Journals in Education** which have the descriptor "Metric System" are:

Ballew, Hunter. Overcoming the Resistance to the Metric System. **School Science and Mathematics** 73: 177-180; March 1973.
Edson, Lee. Metrication: New Dimensions for Practically Everything. **American Education** 8: 10-14; April 1972.
Immerzeel, George and Wiederanders, Don. IDEAS. **Arithmetic Teacher** 19: 362-373; May 1972.
Murphy, Mary Oellerich and Polzin, Maxine A. A Review of Research Studies on the Teaching of the Metric System. **Journal of Educational Research** 62: 267-270; February 1969.
Shaw, R. W. Going Metric—Going Decimal. **Mathematics in School** 1: 23-24; November 1971.
West, Tommie A. The Case for Metric Units. **School Science and Mathematics** 72: 600-602; October 1972.

The April 1973 issue of the "Bulletin for Leaders" of the National Council of Teachers of Mathematics lists the following sources of information on the metric system:

- A brochure entitled "Think Metric" has been produced by the National Education Association in cooperation with the National Council of Teachers of Mathematics. Designed for parents, it covers reasons for metrication, general relationships between the English and metric systems, how metrication will affect the schools, and how parents can help at home and at school. "Think Metric" (stock number 051-02242) may be ordered prepaid from American Education Week, P.O. Box 327, Hyattsville, Maryland 20781, at thirty copies for $2.25. Shipping and handling charges will be added to billed purchase orders. Make checks payable to the National Education Association.
- "All You Will Need to Know about Metric" is a new information sheet that may be reproduced or requested in reasonable quantities from the Metric Information Office of the U.S. Department of Commerce, National Bureau of Standards, Washington, D.C. 20234.
- The National Bureau of Standards Special Publication 304A (revised October 1972), a "Brief History of Measurement Systems with a Chart of the Modernized Metric System," is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 25c. A full-scale wall chart, NBS Special Publication 304, is available from the same office for 55c.
- A joint committee of the American Association of School Librarians (AASL) and the NCTM has prepared a selected bibliography of instructional aids for metrication. This resource is available from AASL, 1201 Sixteenth Street NW, Washington, D.C. 20036, for 20c.

Math Education – Volume 5, Number 1, 1973
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# Publications on the Way . . .

The following publications will be available from ERIC/SMEAC some time after May 15:

**Recent Research in Cognition Applied to Mathematics Learning** by M. C. Wittrock

**Ability and Creativity in Mathematics** by Lewis R. Aiken, Jr.

**Research in Mathematics Education Reported in 1972** by Marilyn N. Suydam and J. Fred Weaver

**Research Reporting Sections: National Council of Teachers of Mathematics 51st Annual Meeting** edited by Jon L. Higgins

**Use of Computers in Mathematics Education Resource Series:**

I. **Computer Innovations in Education** by Andrew R. Molnar
II. **Computer-Extended Problem Solving and Enquiry** by Larry L. Hatfield
III. **Bibliography**
  Part 1. General Educational Role
  Part 2. Languages and Programming
  Part 3. Mathematics Instruction Applications
IV. **Research on Computers in Mathematics Education** by Thomas E. Kieren

For specific information on the cost of each of these, please write (after May 15) to Marilyn N. Suydam, ERIC/SMEAC.

Among publications scheduled later in the year are the proceedings of the Northwestern University symposium on "Cognitive Psychology and the Mathematics Laboratory."

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# Research on Elementary School Mathematics, 1972

Among the research studies reported each year, there are attempts to provide answers to some of the questions which both classroom teachers and other mathematics educators have about the teaching of elementary school mathematics. Suydam and Weaver (1970, 1971) and Suydam (1972) have summarized previous research: this newsletter presents some of the findings from research published during 1972. The focus is on research that the teacher might find useful: that is, research whose findings might be applied in the classroom. Other studies, of more specific information to researchers, are not included.* As this bulletin was prepared, the variability in the quality of research was taken into consideration, as well as its applicability.

## Addition and Subtraction Sentences: What Needs Emphasis?

In the previous bulletin in this series (Suydam, 1972), three research studies on addition and subtraction sentences were reported. Engle and Lerch (1971) found that first graders who had studied in programs without emphasis on closed number sentences could make decisions about basic addition facts stated as either true or false number sentences with a high degree of accuracy. Weaver (1971) reported that sentences of the form $\square - b = c$ or $c = \square - b$ were significantly more difficult than were sentences of the form $\square + b = c$ or $c = \square + b$ for children in grades 1 through 3. Steffe and Johnson (1971) found that problems of the form $a + b = \square$ were easier than problems of the form $a - b = \square$, $a + \square = c$, and $\square + b = c$.

Additional exploration on mathematical sentences was reported in 1972. **Grouws** gave an oral test in which 32 third graders were each asked to solve 16 open sentences of the form $N + a = b$, $a + N = b$, $a - N = b$, and $N - a = b$. Open sentences of the $N - a = b$ type (e.g., $N - 19 = 46$) were significantly more difficult than the other three types. Sentences using basic facts with sums between 10 and 18 were significantly easier for third graders than similar open sentences using addends and sums between 20 and 100. There were no significant differences when some open sentences were presented in a verbal problem. Children used an average of five different solution methods, such as tallying, recall, counting, inverse relationship, and substitution, but high performance was associated with direct addition or subtraction.

It seems apparent that teachers need to give more attention to sentences of the form $N - a = b$. And more attention should be given to open sentences of all four forms where larger whole numbers are involved.

Mathematics programs for young children commonly provide experiences with open addition and subtraction sentences which have a solution within the set of whole numbers. Rarely, however, is explicit attention given to sentences such as $\square + 9 = 6$ or $7 - \square = 11$, each of which has no solution within the set of the whole numbers. **Weaver** collected some evidence on how well first-, second-, and third-grade pupils recognize such "no solution" situations. Test data from 23 classes were presented.

Mean correct responses for open "no solution" addition sentences ranged from 40.8 per cent in grade 1 to 53.6 per cent in grade 2 to 61.3 per cent in grade 3. Performance levels at each grade were not the same for all open-sentence forms, but there was progressively less difference among these performance levels as grade level increased.

For open "no solution" subtraction sentences, the mean per cent of correct responses was essentially the same from grade to grade: 41.6 per cent for grade 1, 41.7 per cent for grade 2, and 41.9 per cent for grade 3. For both open addition and open subtraction sentences, the mean per cent of incorrect use of the "no solution" response decreased from grade to grade, reflecting the progressive improvement in performance.

Thus pupils were not at a complete loss in responding to open addition and subtraction sentences involving the untaught condition of no solution within the set of whole numbers. The ability to identify the "no solution" response was a variable phenomenon associated with such factors as grade level and sentence form. Weaver pointed out that some pupils erroneously assume that subtraction of whole numbers is commutative, and that teachers need to call attention to the **non**-commutativity of subtraction. Emphasis also needs to be given to reading number sentences in left-to-right order. And, rather obviously, instruction on open addition and subtraction sentences which have no solution in the set of whole numbers is needed.

† Prepared by Marilyn N. Suydam, Faculty Research Associate, ERIC/SMEAC

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### Division: Which Algorithm Is Advantageous?

Previous research (Suydam and Weaver, 1970) has identified instructional advantages for various division algorithms. The method of teaching, rather than the algorithm itself, seems to be the key: the division algorithm which is taught with the greatest degree of meaning has tended to lead to higher achievement.

**Kratzer** prepared two instructional units, both involving meaningful instruction. One used the distributive algorithm and the other used the subtractive algorithm, each as a method of keeping records of manipulating bundles of sticks. Three fourth-grade classes were each taught one of the division approaches. No significant differences in the approaches was found on achievement of familiar problems on immediate or retention tests. There was, however, a significant difference between the approaches on achievement of unfamiliar problems on both types of test: the distributive approach group displayed a better understanding of the process.

**Rousseau** undertook an experiment with twelve fourth-grade classes to determine whether or not the foundations on which a division algorithm could be built affect children's ability to retain and transfer on tasks involving the algorithm. Four algorithms were developed on these foundations: (1) mathematical, based on the distributive property of division over addition; (2) real-world, based on the physical act of "quotitioning;" (3) real-world, based on the physical act of partitioning; and (4) rote, based on the memorization of routines. No significant differences in retention of algorithms were found. For extensions to cases of slightly greater difficulty, the rote algorithm was superior. For problems of greater difficulty, however, the quotitive and distributive algorithms were better than the rote and partitive algorithms.

### Problems: What Approach Helps?

Verbal problem-solving continues to draw the attention of researchers. In one study comparing the effects of three approaches, **Jerman** reported no significant differences between fifth-grade groups using a general-problem-solving program, a wanted-given program, or the regular textbook. Some effect on strategies, especially for the wanted-given approach, was noted. Jerman pointed out the dependence of problem-solving skill on computational ability. Perhaps we cannot expect students to solve more problems correctly unless we place emphasis on the required computational skills along with the problem-solving strategies.

### Materials: What Helps Whom?

Research on the use of materials continues to indicate that the use of materials is very important, but that we need to consider carefully what, when, how, and by whom they are used. What outcomes are to be expected must also be considered.

**McLaughlin** found that pupils in grades 2 and 4 were able to reproduce behavior on a multiple-classification block task which they had seen demonstrated; only sixth graders, however, could transfer the information to a different but structurally similar task. Both "model" and "trial-and-error practice" conditions produced similar performance, but the "model" condition had a greater effect on pupils' knowledge about the relationships of the objects involved in the classification.

In a study in which various types of materials were used, **Wheeler** analyzed the relationship of the child's performance in solving two-digit addition and subtraction examples on four concrete embodiments and two-digit and multi-digit addition and subtraction examples in the symbolic mode. He tested the performance of 144 second graders on the use of the abacus, bundling sticks, the place value chart, and multi-base arithmetic blocks, and then gave them two-digit and multi-digit addition and subtraction examples in written form. There were no significant differences between the means of the children, at any of three levels of abstraction for regrouping, in solving two-digit examples in the symbolic mode. However, children proficient in regrouping two-digit examples on three or four embodiments scored significantly higher on the multi-digit written tests than children who were not proficient using the concrete materials, across all IQ levels. Significant correlations were found between the number of embodiments children were able to regroup for two-digit examples and achievement on the multi-digit tests.

It was concluded that children proficient in regrouping two-digit addition and subtraction examples on three or more concrete embodiments possess a significantly higher level of understanding of the regrouping concept than children without this proficiency with the concrete aids. This supports the multiple embodiment hypothesis that concept formation is facilitated through the use of a variety of materials.

As has also been found in some previous research, **Clausen** reported that kindergarten and first grade pupils exposed to a multi-sensory approach achieved higher than pupils using a worksheet-textbook approach.

### Questions: What Kinds Are Needed?

Many recent studies have explored the type and quality of various classroom behaviors. **Meckes** studied teacher-pupil interaction and teachers' questioning patterns for mathematics classes in grade 6. A tape recording was made of one class session conducted by each of 100 teachers, and ten-minute segments of the tape were analyzed. All teacher-questions were also transcribed and categorized. Results indicated that the role of the mathematics teacher has not changed from that of giving information to that of guiding learning experiences. This conclusion was supported by the following evidence: The teacher spent 61.5 per cent of the time talking. Direct influence accounted for 50.2 per cent of the teacher talk. Although indirect influence amounted to 49.8 per cent of the teacher talk, the largest portion of this was in the questioning category. And since most of these questions were very narrow, they provided little opportunity for students to express their own ideas.

The intent of the new mathematics programs and present classroom practices were also shown to be inconsistent. Although one of the primary objectives of the new mathematics is to foster a spirit of inquiry and to develop creativity, only .5 per cent of the total questions were placed in the synthesis category. The two low cognitive level categories accounted for 79.5 per cent of the questions asked.

The need for teachers to develop questioning at the high cognitive levels is evident.

The use of questions was also found in connection with an experimental study. **Nichols** found that first-grade child-

ren who had to respond orally to three questions about why they answered correctly took fewer trials to reach criterion on number conservation tasks than did children who did not answer questions following correct responses. Her three questions: "Why? How do you know? Can you tell me more?" Teachers can readily apply these in many classroom situations.

### Cognitive Levels: What Do Children Need?

**Burron** examined the assumption that all children of various abilities can profit from instruction at a variety of cognitive levels. Five process exercises were developed, comprised of mathematical tasks designed to elicit responses at a variety of levels. Data were then collected from two groups of approximately 40 sixth-grade pupils each, who had been selected as having high or low success-potential. Significant differences favored the high group for every cognitive level except "data-generation." The proportion of pupils functioning successfully within each group increased as cognitive level ascended, but ability to function successfully at a given cognitive level was neither discrete or consistent with group membership. At least half of the low group attained "a respectable measure of success" at every cognitive level.

Burron concluded that differences in the ability to function successfully at a variety of cognitive levels seemed more related to the level of complexity of a task than to cognitive level. Challenging **all** pupils to stretch their modes of thinking on a variety of cognitive levels seems to be a valid educational objective. Differences in individual cognitive styles imply tasks structured to include a large domain of possibilities, alternatives, and opportunities to achieve goals in a multiplicity of ways.

In the study, a marked difference in behavior related to self-confidence was also noted. Pupils in the low group seemed hesitant, threatened, or reluctant to respond to divergent questions, while high-group pupils displayed little of this behavior. Pupils in both groups showed preference for manipulatory activities; non-manipulatory tasks evoked a drop in interest and enthusiasm among the low-group pupils, while high-group pupils were able to sustain activity.

In another study dealing with cognitive levels, **Callahan and Passi** examined three series of elementary-school mathematics textbooks, two contemporary and one "premodern," for grades 3-6. Instances were noted of the occurrence of seven cognitive levels: knowing, translating, manipulating, choosing, analyzing, synthesizing, and evaluation. More than half of the cognitive activities found in the series were classified at the "manipulating" level. Few activities were classified as "translating." Newer series had more "knowing" items than the older series did. Little was done at the three high cognitive levels. It would appear that much supplementing of the textbook by the teacher needs to be done, so that children are asked questions and given activities at all cognitive levels.

### Instructional Sequences: How Should They Be Developed?

**Buchanan** examined instructional sequences to determine how prior experience with subordinate tasks affected mastery of a superordinate task, and the efficiency of performance within a sequence. In Experiment I, 72 fifth-graders used paired-associate-type cards for problems in modulo 12. In Experiment II, 120 sixth graders used an instructional program on set-union. The amount of prior experience with the introductory task had a significant effect on mastery of the superordinate task.

In Experiment I, the number of errors and learning trials on the task increased significantly with increasing amount of prior experience, not entirely independent of presentation order. The transfer task in Experiment II indicated that prior experience with the introductory task inhibited the performance of low-aptitude students.

**Phillips** developed and evaluated procedures for validating a learning hierarchy from test data. A test to assess mastery at each of 11 levels of a hierarchy for computational skills of adding rational numbers with like denominators was administered and seven hierarchical orderings of the 11 subtasks were generated. One programmed instruction lesson was developed for each subtask. Fourth-grade pupils were assigned to seven groups defined by the hierarchical orderings. Results indicated that sequence, even if random, seemed to have little effect on immediate achievement and transfer to a similar task. However, longer term retention seemed quite susceptable to sequence manipulation.

In one of a set of studies, **Sawada** studied a strategy for organizing a curriculum into a mathematically-cast system with explicit structural mediators of positive transfer from lower- to higher-order objectives. Three axioms were specified in mathematical form such that the system was characterized by composition and reversibility. Eleven instructional sequences were presented via computer-assisted instruction. It was found that performance on an objective had little relationship with performance on the inverse objective. Pupils on their own apparently did not pick up the strategy of forming composites. In other words, pupils did not seem aware of reversibility inherent in the materials, nor of composition objectives. The need for explicit teaching, rather than expecting transfer to occur as a by-product, is indicated.

### Motivation: What Works?

**Rea and French** reported on a small-scale research study with a class of sixth graders. One group used mental computation exercises; the other was given enrichment activities using the same content. Tests were given on the first and twenty-fifth days, with 24 instructional periods intervening in which both groups received their regular mathematics period **plus** 15 minutes daily of the special activities.

As the authors point out, in both groups were individuals whose scores increased only slightly, and scores even decreased for a few. However, in both groups, the majority of the students gained rather dramatically; the average gain for the enrichment group on the achievement test was one full year, and for the mental computation group was eight months.

While the study is subject to many limitations, the increase in achievement scores seems to be worth pursuing, both in more rigorously designed experiments and in classroom situations where a similar set of experiences may be desirable. There can be little doubt that the results were influenced by factors such as the halo effect, which often accompanies enthusiastic experimentation. But why not capitalize on this in the classroom? Children do like variety —and children enjoy experimenting and being part of an experiment. Research is a way of motivating children.

**Schultz** studied some factors related to motivation: the combined influence of teacher facilitative behavior and the

effect of interpersonal compatibility between teacher and student. Each of 20 tutors was assigned one student who appeared most compatible and one student least compatible to him, determined by responses to a test on interpersonal relationships. Student increases in achievement and in self-concept of arithmetic ability after nine tutoring sessions did not appear to be related to tutor predisposition of facilitative behavior and/or degree of interpersonal compatibility between tutor and student. However, when compatibility was present, students rated their relationships with tutors as more facilitative.

### Logic: How and What?

**Sheppard** studied one aspect of the development of concept learning; the concept was a two-attribute, conjunctive, non-verbal one about right triangles. Two groups of 40 fifth graders were tested individually. Each saw one example and three non-examples. Giving divergent examples was found to be better than giving convergent examples; giving matched non-examples was better than giving non-matched non-examples. The combination of divergent examples and matched non-examples yielded predominantly correct classification behavior. Other combinations resulted in either over- or under-generalization—or confusion.

**Fetzer** gave 27 logic problems differing in content and validity to 206 students aged 8 through 15. Problems involving conflict were found to be more difficult than corresponding agreement and neutral forms. Those involving invalid assumptions were found to be more difficult than those having validity. In general, younger children appeared to base their judgments on the empirical conditions and did well on problems where the logical and empirical cues agreed, whereas older children were able to disregard the empirical content and base their judgments on the logical structure of the problem. Thus young children may appear to be responding to the logical structure of a problem when in fact they are responding merely to the truth of the empirical content.

* A complete annotated listing of studies published during 1972 is available from ERIC/SMEAC. The listing will also appear in the November 1973 issue of the **Journal for Research in Mathematics Education.**

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**"DAI" refers to *Dissertation Abstracts International.*

# CENTER CLIPPINGS...

These documents are some of those announced in Research in Education during April or May 1973.

**ED 071 879** SE 015 509
**Sixth Grade Mathematics. A Needs Assessment Report.**
Texas Education Agency, Austin. Div. of Program Planning and Needs Assessment.
Pub Date 72
Note—132p.
**EDRS Price MF-$0.65 HC-$6.58**
Descriptors—Academic Performance, Educational Objectives, *Elementary School Mathematics, Grade 6, *Mathematics Education, *Objectives, *Student Evaluation, Student Testing, *Testing Programs
The Prescriptive Mathematics Inventory (PMI)-Level B and a Pupil Identification Form (PID) were administered to 22,055 sixth graders in Texas. Results from the PMI are reported in terms of the percentage of students marking the correct response for each of 209 objectives. Panels of mathematics teachers and of mathematics experts rated 40 of these objectives as "basic"; this report summarizes the basic objectives and gives the percentage of sixth graders mastering the objective as shown by the PMI. In addition, students' performance on each of the 209 objectives was analyzed on the basis of pupil characteristics obtained through the PID and according to the characteristics of the schools they attended. Results showed wide variations in achievement of objectives; for each objective, wide variations in performance were found among pupils of various ethnic groups, among students of schools serving communities of various sizes and types, and between pupils having high and low educational emphasis at home. Possible uses for this report are suggested. (Author/DT)

**ED 071 878** SE 015 508
*Briggs, John W.*
**Idaho Curriculum Guide in Mathematics K-12.**
Idaho State Dept. of Education, Boise. Div. of Instruction.
Pub Date Sep 70
Note—331p.
**EDRS Price MF-$0.65 HC-$13.16**
Descriptors—*Behavioral Objectives, Curriculum, *Curriculum Guides, *Elementary School Mathematics, *Instruction, *Mathematics Education, Secondary School Mathematics, Teaching Techniques
The content of this guide has been organized under five major topics: number and operations; sets, functions, relations, systems, and logic; geometry; measurement and estimation; and selected topics. A scope and sequence chart is given for each of the topics for grades K-12. Behavioral objectives, teaching aids and suggestions are listed for each of the topics at every grade level from K-8. A list of 17 references on problem solving is included. (DT)

**ED 070 656** 24 SE 015 465
*Harvey, John G.*
**The Content of Arithmetic Included in a Modern Elementary Mathematics Program.**
Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
Spons Agency—National Center for Educational Research and Development (DHEW/OE), Washington, D.C.
Bureau No—BR-5-0216
Pub Date Oct 71
Contract—OEC-5-10-154
Note—45p.; Working Paper No. 79
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Arithmetic, *Curriculu: Development, *Elementary School Mathematics, Geometric Concepts, *Instruction, *Mathematics Education, Number Concepts, Program Descriptions
Identifiers—Number Operations
Details of arithmetic topics proposed for inclusion in a modern elementary mathematics program and a rationale for the selection of these topics are given. The sequencing of the topics is discussed. (Author/DT)

**ED 071 918** SE 015 640
*Greenwood, Jonathan*
**Resources for Individualizing Mathematics.**
Oregon State Dept. of Education, Salem.
Pub Date [73]
Note—20p.
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Activity Learning, *Annotated Bibliographies, Evaluation, *Individualized Instruction, Instruction, *Instructional Materials, Laboratory Procedures, Manipulative Materials, *Mathematics Education, Objectives
The process of establishing an individualized mathematics program is discussed. An annotated list of references covering program and course goals and objectives, diagnostic and achievement tests, teacher reference books, and activity sources is provided. Twenty-one articles from "The Arithmetic Teacher" which offer a rationale for the activity approach and which suggest suitable activities are also listed. Addresses are provided for 16 commercially produced activity cards and packages and for 15 sources of mathematics laboratory equipment, games, and enrichment materials. (DT)

**ED 071 870** SE 015 453
*Lowry, William C., Ed.*
**The Slow Learner in Mathematics. NCTM Yearbook 35.**
National Council of Teachers of Mathematics, Inc., Washington, D.C.
Pub Date 72
Note—528p.
Available from—National Council of Teachers of Mathematics, 1201 Sixteenth Street N. W., Washington, D.C. 20036 ($8.50, $7.50 for NCTM members)
**EDRS Price MF-$0.65 HC Not Available from EDRS.**
Descriptors—*Activity Learning, *Curriculum, *Instruction, Instructional Materials, Laboratory Procedures, *Mathematics Education, Objectives, *Slow Learners, Teacher Education, Teaching Methods
The first part of this yearbook treats the characteristics and needs of the slow learner, the research literature, behavioral objectives, and the creation of a favorable learning environment. The second part, meant to provide more specific help for the classroom teacher, deals with teaching techniques, multisensory aids and activities, mathematics laboratories, and diagnostic-prescriptive procedures. The third part covers classroom management and school administration, curriculum for slow learners, and program descriptions for in-service teacher education. Two appendices present activities, games, applications, and sample lessons that have been found to be effective with slow learners. (Author/DT)

**ED 070 026** CG 007 712
*Vroegh, Karen S.*
**The Relationship of Sex of Teacher and Father Presence-Absence to Academic Achievement.**
Institute for Juvenile Research, Chicago, Ill.
Spons Agency—Office of Education (DHEW), Washington, D.C.
Bureau No—BR-1-E-103
Pub Date Aug 72
Grant—OEG-5-71-0045(509)
Note—125p.
**EDRS Price MF-$0.65 HC-$6.58**
Descriptors—*Academic Achievement, *Elementary School Students, Elementary School Teachers, *Fathers, Language Instruction, Mathematics, Parent Child Relationship, *Parent Role, Parents, Reading Achievement, *Student Teacher Relationship, Teachers
This report contains the findings of five specific hypotheses which were tested concerning the relationship of sex of teacher, sex of child, and extent of father presence to academic achievement. Residual change scores in mathematics, reading, and language were subjected to regression analyses and three-way analyses of variance. The subjects in the study were 201 girls and 215 boys in the fourth and fifth grade classrooms of 14 male and 14 female teachers. The measures of extent of father presence-absence came from mothers' responses to a father activity inventory. The analyses generally indicated that none of the independent variables were related to the achievement scores. The report states that future research should consider intervention at an earlier age, quality of father presence, teacher quality, and developmental sex differences. (WS/Author)

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## News Notes

**Listing of Journals**

The External Affairs Committee of the National Council of Teachers of Mathematics has compiled a "Listing of Foreign and Domestic Journals in Mathematics Education." The "Listing" gives titles and addresses for various foreign and domestic journals as well as, where possible, an indication of education level(s) dealt with in journal articles. The journals are concerned with topics in mathematical education, as opposed to pure mathematics and as opposed to general education. Persons interested in having a copy of the "Listing" should request one (postcard or letter) by writing to: **Listing Request**, National Council of Teachers of Mathematics, 1906 Association Drive, Reston, Virginia 22091.

**Correction . . .**

The single copy price for **Current Index to Journals in Education** is $3.70 (not $3.50 as listed in the last Newsletter).

**Emphasis: Metrication**

A **metric conference and exhibit,** "Going Metric: Meeting the Conversion Challenge," is scheduled for September 7-8, 1973, on the UCLA campus. The conference is designed to aid industry in its plans for making the metric conversion and to speed up the public's understanding and acceptance of the metric system. A highlight for teachers will be a credit-giving metric workshop. For further information on the conference, contact: Mrs. Valerie Antoine, 10245 Andasol Avenue, Northridge, California 91324.

The **Toll Gate Metrication Project** is an educational experiment for elementary through junior college students, aimed at implementing change toward adoption of the metric system. The project is financed by an ESEA Title III Minigrant through the Rhode Island State Department of Education. Project findings and recommendations will be made available in the summer of 1973. Anyone wishing to receive information should send a self-addressed and stamped envelope to: John Izzi, Director, Toll Gate Metrication Project, Toll Gate Education Complex, Warwick, Rhode Island 02886.

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SMEAC
NEWSLETTER
AN ERIC CENTER

# Research on Secondary School Mathematics, 1972[†]

Questions about what, when, or how to teach mathematical topics and ideas arise every day. Researchers as well as teachers (and remember: most researchers are teachers, too!) try to find answers to such questions. This review presents some of these investigations which were published during 1972. (For reports of such research in previous years, see Suydam, 1972a and 1972b). In selecting these studies, the primary criterion was: do the findings have meaning for the teacher—that is, are the findings applicable in the classroom? Studies whose findings would appear to be of interest primarily to other researchers are not included.* Other criteria involved evaluation of the research report: how carefully the research was designed and carried out was considered.

See if any of your questions have been explored!

### Materials: What Helps Whom?

In a review of research on the role of materials, **Fennema** concluded that research appears to indicate that the ratio of concrete to symbolic models used to convey mathematical ideas should reflect the developmental level of the learner. Thus, alternative models should be available so the learner can select the most meaningful one for him.

Researchers continue to explore such alternatives, as well as the role of materials **per se**. For instance, in a study involving 65 geometry students, **Waters** found that there were no significant achievement or attitude differences between groups using circular geoboards, the geosheet (a two-dimensional version of the geoboard), or "conventional classroom methods."

**Kuhfittig** looked at the role of materials in relation to "guided discovery" learning. He selected 40 seventh graders at two achievement levels, and randomly assigned them to four groups using (1) either intermediate or maximal guidance and (2) either abstract or concrete materials, for a two-day unit on currency conversion. The intermediate guidance groups had a carefully structured sequence of questions, while the maximal guidance groups had careful explanations of individual steps. Low-ability students who used concrete materials achieved better than low-ability students who did not use materials; no difference was found between high-ability students. For intermediate-guidance groups, mean transfer-test scores for students using concrete aids were higher than scores of those not using aids; no difference was found for maximal-guidance students.

**Shoecraft** investigated the effects of three instructional approaches on translating selected types of algebra word problems: direct translation, high imagery with materials, and high imagery with drawings. Twelve seventh-grade mathematics classes and ten ninth-grade algebra classes spent eight days on differential treatments of number, coin, and age problems, and four days on identical treatment of work and mixture problems. It was concluded that, except for low achievers who seemed to derive particular benefit from representing problems with materials, students taught to translate directly performed comparably to those experiencing material referents and superior to those experiencing pictorial referents. Shoecraft added: "Thus the popular assumption that materials and/or pictorial representation of mathematics in and of itself enhances mathematics learning is perhaps unjustified. To expect such representation to facilitate mathematics learning is to assume that the mathematics implicit in the use of materials and drawings is descriptive of what is going on in the heads of students. The disparity between the two was evident in this study."

### Mathematics Laboratories: How Effective?

Research reflects continued concern with the effectiveness of a laboratory or activity approach. **Vance and Kieren** reported on a ten-week investigation of the effectiveness of laboratory activities used once a week in grades 7 and 8. In the Mathematics Laboratory Group, students worked in groups of two, with written instructions and physical materials to help them discover concepts or relationships, then did practice exercises. In the Class Discovery Group, the same content was used, but the teacher demonstrated with concrete materials, leading the group to discover. The Control Group had the regular program with no laboratory work.

No significant differences were found in achievement of content covered in the regular program, even though class

[†] Prepared by Marilyn N. Suydam, Faculty Research Associate, ERIC/SMEAC

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time was spent in informal exploration. Students in the two treatment groups achieved about the same on tests of content done in the laboratory, except that average- and low-ability seventh graders did better in the Class Discovery Group. Both Laboratory and Class-Discovery Groups scored higher than students in the regular program on cumulative achievement, transfer, divergent-thinking, and attitude measures.

In a study with eight tenth-grade classes using geometry content, **White** found that inquiry lessons used with individualized teaching-learning units significantly increased critical thinking, achievement, and retention scores for average- and high-ability students. Laboratory lessons significantly increased achievement and retention scores for low- and average-ability students. Students in the laboratory group made the greater gain in scores for attitude toward mathematics.

**Silbaugh** studied 36 seventh-grade mathematics classes. Twelve classes attended multiple-activities laboratories twice a week during the school year; 12 classes were housed in the same school but did not attend the laboratories; 12 classes were in schools with no laboratories. The students who attended the laboratories appeared to achieve significantly higher on a standardized test.

In a 14-day study with eighth-graders, **Whipple** taught elementary concepts of metric geometry to two classes by a laboratory method emphasizing use of manipulative materials, while two classes used individualized instruction units. Students in the laboratory group scored higher on conventional written tests and showed better ability to compute areas and volumes using actual objects. No differences in spatial perception were found.

**Johanson** developed a nine-week curriculum for a ninth-grade class using apparatus and experiments which involve active manipulation, with game-playing, discussion, and children working in pairs or in small groups. The group taught with this curriculum scored higher on achievement and attitude measures than did a control group.

**Dittmer** presented responses to specific questions related to guidelines for developing a mathematics laboratory, from state supervisors and from teachers using a laboratory approach in grades 7-12.

#### Computers and Calculators: What Approach?

**King** conducted a formative pilot study with six ninth-grade classes. For five weeks, the general mathematics course was supplemented by one of three instructional procedures: mastery learning, or mastery learning and flowcharting with or without computer access. It was found that the low-achieving students could master the objectives of the unit particularly when flowcharting accompanied mastery learning.

Approximately 70 seventh-grade mathematics students worked in self-instructional booklets for 15 weeks, in a study by **Durall**. Upon completion of each booklet, the student was evaluated by direct contact with a computer through teletype terminals. If the criterion of 80 per cent was not attained, half of the students received remediation from an instructional sequence programmed into the computer. The other half received remediation from their teacher. Both groups achieved comparably, but remediation from the teacher appeared to be more supportive for low-ability students.

In studies previously summarized in Suydam (1972a), **Hatfield and Kieren** reported that use of computer programming as a problem-solving tool was especially helpful for average and above-average students in grade 7; in grade 11, it appeared best for average achievers.

**Gaslin** assigned six classes of ninth-grade general mathematics students to three treatments: a conventional algorithm set consisting of the usual textbook approach, used with or without a calculator, and an alternative algorithm set where each fractional operand was converted to a decimal, used with a calculator. Five mastery-learning units were used for an eight-week period. For low-ability or low-achieving children, the alternative algorithm with the calculator was found to be a "viable alternative" to the conventional algorithm with or without the calculator for promoting computational skill with positive rational numbers. Use of the calculator did not significantly affect performance with the conventional algorithm.

#### Objectives: Does Explicitness Help?

**Loh** investigated the use of behavioral objectives with two second-year algebra classes. Students who were informed of behavioral objectives did not learn or retain better than students not informed of objectives.

On the other hand, **Harris** found that, for four geometry and algebra classes, prescribed content with set daily goals, feedback, and systematic reinforcement increased achievement in each course.

#### Achievement: What is Students' Status?

**Austin and Prevost** reported that computation scores for eighth graders were lower in 1967 than in 1965 or 1963; different achievement tests were used, however. In grade 10, those students who had used "modern" or "transitional" textbooks in earlier grades scored higher on some subtests than did those who had used "traditional" textbooks.

**Hammons** found a significant decline in computational skills in eighth grades in Louisiana schools studied during 1960-1969, but a significant change in reasoning was not found.

#### Organization: How is Mathematics Learning Affected?

**Gaskill** studied the relationship between achievement and personal adjustment in middle schools and in junior high schools. Scores from 846 eighth graders from middle schools and 381 eighth graders from junior high schools indicated that differences in mean gain in achievement significantly favored the junior high school group. No differences in personal adjustment were found between the two organizational patterns.

**Buchman** studied low-achievers in ninth grade from schools providing only a two-semester algebra course, a three-semester course for low achievers and "slow workers," or a four-semester course. He found no differences in achievement, but some affective aspects were better in the lengthened courses.

#### Personality: What Characteristics Affect Mathematics Learning?

**May** identified students as "sensing" or "intuitive" personality type. The 295 eighth graders' scores on achievement and attitude measures were then compared. A

significant difference in computation, concepts, and applications scores was found between sensing and intuitive types. No differences in attitudes toward mathematics were found. May concluded that teachers should consider type of personality when planning instruction.

### Teacher Strategies: What Patterns Are Used?

**Gregory** studied 20 teachers and their seventh-grade classes. He had one of each teacher's classes audio-taped five times, and administered a reasoning test to students at the beginning and end of the semester. The teachers were ranked on the basis of analysis of the frequency of their conditional moves: that is, how often did they use "if-then" language in their teaching. Students of teachers who used such language more frequently outperformed students of teachers who made fewer such statements, on the reasoning tests. Thus the teacher, through use of logical language in a variety of situations, can help students to develop greater achievement in logic.

**Wolfe** listed eight strategies observed being used by 11 mathematics teachers in grades 9 and 10 in an investigation of the verbal activity or "justification" as it is carried out in the classroom. Criteria for identifying justification ventures and "moves" in such ventures were also noted.

**Cooney and Henderson** attempted to identify methods of instruction which prove effective in helping students to structure their knowledge; that is, to organize in a meaningful way the concepts, facts, and principles they learn. From audiotapes of 44 instances of mathematics teaching by ten teachers in grades 7 through 12, they identified nine organizing relations: set membership, set inclusion, analysis, specifying, characterizing, explaining, implicating, generalizing, and abstracting. These are described: teachers might find it interesting to check these descriptions and compare them with their own classroom procedures.

* A complete annotated listing of studies published during 1972 is available from ERIC/SMEAC. The listing will also appear in the November 1973 issue of the *Journal for Research in Mathematics Education*.

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Gregory, John William. The Impact of the Verbal Environment in Mathematics Classrooms on Seventh Grade Students' Logical Abilities. (The Ohio State University, 1972.) *DAI* 33A: 1585; Oct. 1972.

Hammons, Donald Wayne. Student Achievement in Selected Areas of Arithmetic During Transition from Traditional to Modern Mathematics (1960-1969). (The Louisiana State University and Agricultural and Mechanical College, 1972.) *DAI* 33A: 2237; Nov. 1972.

Harris, Jasper William. An Analysis of the Effects of Using Quizzes and Modified Teaching Procedures to Increase the Unit Test Scores in Geometry, Algebra, and French Classes in an Inner City Senior High School. (University of Kansas, 1972.) *DAI* 33A: 2648; Dec. 1972.

Hatfield, Larry L. and Kieren, Thomas E. Computer-Assisted Problem Solving in School Mathematics. *Journal for Research in Mathematics Education* 3: 99-112; Mar. 1972.

Johanson, Emma Jane Dixon. A Ninth Grade Piagetian Mathematics Curriculum. (The University of Toledo, 1972.) *DAI* 33A: 223; July 1972.

King, Donald Thomas. An Instructional System for the Low-Achiever in Mathematics: A Formative Study. (The University of Wisconsin, 1972.) *DAI* 32A: 6743; June 1972.

Kuhfittig, Peter Kurt Friedrich. The Effectiveness of Discovery Learning in Relation to Concrete and Abstract Teaching Methods in Mathematics. (George Peabody College for Teachers, 1972.) *DAI* 33A: 1323; Oct. 1972.

Loh, Elwood Lockert. The Effect of Behavioral Objectives on Measures of Learning and Forgetting on High School Algebra. University of Maryland, 1972.) *DAI* 33A: 145; July 1972.

May, Daryle Cline. An Investigation of the Relationship Between Selected Personality Characteristics of Eighth-Grade Students and Their Achievement in Mathematics. (The University of Florida, 1971.) *DAI* 33A: 555; Aug. 1972.

Shoecraft, Paul Joseph. The Effects of Provisions for Imagery Through Materials and Drawings on Translating Algebra Word Problems, Grades Seven and Nine. (The University of Michigan, 1971.) *DAI* 32A: 3874-3875; Jan. 1972.

Silbaugh, Charlotte Vance. A Study of the Effectiveness of a Multiple-Activities Laboratory in the Teaching of Seventh Grade Mathematics to Inner-City Students. (The George Washington University, 1972.) *DAI* 33A: 205; July 1972.

Suydam, Marilyn N. *A Review of Research on Secondary School Mathematics*. Columbus, Ohio: ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, Mar. 1972.

Suydam, Marilyn N. From the Research of 1971 on Secondary School Mathematics. In Mathematics Education Newsletter, Volume 4, Number 2. Columbus, Ohio: ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, 1972.

Vance, James H. and Kieren, Thomas E. Mathematics Laboratories—More than Fun? *School Science and Mathematics* 72: 617-623; Oct. 1972.

Waters, William Meade, Jr. A Study to Test the Effectiveness of a Circular Geoboard as an Instrument for Teaching Selected Arc-Angle Theorems. (The Florida State University, 1971.) *DAI* 32B: 6530-6531; May 1972.

Whipple, Robert M. A Statistical Comparison of the Effectiveness of Teaching Metric Geometry by the Laboratory and Individualized Instruction Approaches. (Northwestern University, 1972.) *DAI* 33A: 2699-2700; Dec. 1972.

White, Virginia Taffinder. An Evaluation Model to Test Teaching-Learning Units for Individualized Instruction in Mathematics. (University of Washington, 1972.) *DAI* 33A: 2247-2248; Nov. 1972.

Wolfe, Richard Edgar. Strategies of Justification Used in the Classroom by Teachers of Secondary School Mathematics. *School Science and Mathematics* 72: 334-338; Apr. 1972.

** "DAI" refers to *Dissertation Abstracts International*.

# News Notes

### NCTM's New Address

The new address of the National Council of Teachers of Mathematics is: 1906 Association Drive, Reston, Virginia 22091. NCTM moved into the new building in April; the formal dedication was early in May. It is one of the first buildings in a new educational park setting.

### International Symposia Coming Up

The Second International Congress on Mathematical Education (ICME) was held at Exeter University in England during late summer, 1972. That Congress exhibited a strong interest in discussion of aspects of mathematical education on a wide international scale. The International Commission on Mathematical Instruction (ICMI) responded by giving sponsorship to international symposia, some of which are listed here for the benefit of American mathematics educators. For information concerning particular symposia, please write directly to the person and addresses listed.

(1) **Poland.** Symposium at Warsaw; 1974.

Main Subject: Mathematics in Primary Schools (Children from 6 to 11 years of age.)

Professor Z. Semadeni, Institute of Mathematics, Polish Academy of Sciences, UL. Sniadeckich 8, Warszawa 1, Poland.

(2) **Africa.** Regional Conference. Probably Nairobi, 1974.

Main Subject: Interactions between mathematical education and linguistics.

Dr. D. Saint-Rossy, UNESCO House, Malik Street, PO Box 30592, Nairobi, Kenya.

(3) **Japan.** ICMI-JSME Tokyo Conference: 1974. Preliminary proposal: 5-9 November, 1974;

Main Subject: Curriculum and teachers' training.

Professor S. Iyanaga, 12-4, Otsuka 6-Chome, Bunkyo-Ku, Tokyo, Japan.

(4) **India.** Regional Conference; late 1974.

Main Subject: The Development of an integrated curriculum in mathematics for the underdeveloped countries.

Professor P. L. Bhatnagar, Dean of Studies, Department of Mathematics, Himachal Pradesh University, Simla 5, India.

### Computer Searches

Computer searches of the ERIC document base are available from various concerns. Here is some information on several:

* Systems Development Corporation has developed a service for searching the ERIC files from a terminal in your own office. Documents may be requested by accession number, clearinghouse code, author, title, publication date, descriptors, identifiers, institution or source of origin, sponsoring agency, and/or issue. Multiple categories may be selected within a single request. If a printout of all items found in a search is desired, it can be accomplished on-line at the terminal, or off-line, which saves terminal time costs. Off-line printed items are air-mailed to your address the same day as requested. For further information, write:

System Development Corporation
SDC/ERIC Search Service, Room 3113
2500 Colorado Avenue
Santa Monica, California 90406

* The New England Research Applications Center (NERAC) at the University of Connecticut is disseminating retrospective and selective information from the ERIC files. Users of the search service will be given assistance in instructing and implementing searches. For further information, write:

Dr. Daniel U. Wilde
Director, New England Research Applications Center
Mansfield Professional Park
Storrs, Connecticut 06268

* The Resource Information Center has available a low-cost computer software package for searching the ERIC files. The first phase locates and prints a list of accession numbers. The second phase prints abstracts and other selected information found in **RIE** and **CIJE**. The software package can be installed on any IBM 360 from a Model 30 upwards. For further information, write:

Edward Krahmer, or Kent Horne
Resource Information Center
Box 8009 University Station
Grand Forks, North Dakota 58201

* Oregon Total Information System (OTIS) will do ERIC subject searches for institutions, on ERIC records dated 1969 or later. The logical operators "or," "and," "and not" may be used, with no more than 20 descriptors. Up to 130 citations can be printed. For further information, write:

Benjamin L. Jones
OTIS
354 East 40th Avenue
Eugene, Oregon 97405

# CENTER CLIPPINGS...

These documents are some of those announced in Research in Education during June or July 1973.

**ED 072 544** EA 004 877
*McGrady, Donna S.*
**Open Space Elementary Schools: An Annotated Bibliography.**
Indiana State Univ., Terre Haute. Curriculum Research and Development Center.
Pub Date Jan 73
Note—24p.
Available from—Curriculum Research and Development Center, Jamison Hall, School of Education, Indiana State University, Terre Haute, Indiana 47809 ($1.00)
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Annotated Bibliographies, Building Design, *Classroom Furniture, *Elementary Schools, Literature Reviews, Newsletters, *Open Plan Schools, Research, *School Architecture, Space Utilization
This bibliography brings together most of what has been written about open space elementary schools since 1968. The citations are categorized as (1) general, (2) research, (3) schools, (4) furniture, (5) newsletters, or (6) bibliographies. Articles and bound materials are entered alphabetically in the most appropriate section. No attempt was made to include literature dealing with the educational programs that may take place in open space. Prices and addresses have been included when applicable. (Author)

**ED 074 110** TM 002 473
*Ellis, E. N.*
**Survey of Achievement in Mathematics in Year Six of Vancouver Schools, May 29 - June 2, 1972.**
Vancouver Board of School Trustees (British Columbia). Dept. of Planning and Evaluation.
Pub Date 22 Jun 72
Note—15p.; Research Report 72-11
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—*Achievement Tests, Comparative Analysis, Elementary School Mathematics, *Grade 6, Group Norms, *Mathematics, Tables (Data), Technical Reports, Test Results
Identifiers—Canada, *Vancouver
A survey test in mathematics was administered to all pupils (N=5,557) in grade 6 of Vancouver schools. The three parts of the test--computation, concepts, and problems, were given in separate sessions. The same test was given in 1969. The median scores in 1972 for the three subtests and for total score were somewhat lower than those in 1969. A larger number of students had perfect scores in 1972 than in 1969. Students above the 90th percentile performed slightly better than did their counterparts in 1969. Students in both years performed least well on the concepts subtest. Local norms and ranges of scores corresponding to letter grades are provided. (For related document, see TM 002 474.) (KM)

**ED 073 162** TM 002 411
**Experiences With Sets and Numbers: Mathematics Evaluation Materials Package Project.**
Ontario Inst. for Studies in Education, Toronto.
Pub Date 72
Note—102p.; Curriculum Series/14
Available from—Ontario Institute for Studies in Education, 252 Bloor Street West, Toronto 5, Ontario (no price quoted)
**Document Not Available from EDRS.**
Descriptors—Criterion Referenced Tests, *Educational Objectives, *Evaluation Methods, Grade 4, Grade 5, Grade 6, Instructional Design, *Mathematics Education, *Performance Tests, Student Testing, *Test Construction
Identifiers—Canada, *Mathematics Evaluation Materials Package, MEMP, Ontario
The Mathematics Evaluation Materials Package (MEMP)is a set of objectives and companion test items for mathematics education in Grades 4 to 6. The educational objectives are stated in terms of student performance and are coupled with companion test items. In this package are some companion items for objectives that are commonly used for the topic, "Experiences with Sets and Numbers," in Grades 4 to 6 in Ontario schools. Answers to the test items are provided. Sample inventories made up of models of types of papers that can be prepared by teachers by combining various items are provided. MEMP can be used to design tests covering short units of work or for constructing longer tests. (DB)

**ED 072 599** EC 051 118
*Suppes, Patrick*
**A Survey of Cognition in Handicapped Children. Technical Report No. 197.**
Stanford Univ., Calif. Inst. for Mathematical Studies in Social Science.
Spons Agency—Bureau of Education for the Handicapped (DHEW/OE), Washington, D.C.
Pub Date 29 Dec 72
Grant—OEG-0-70-4797(607)
Note—77p.
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—Aurally Handicapped, *Blind, *Cognitive Development, Concept Formation, *Deaf, *Exceptional Child Research, Language Ability, Mathematics, *Mentally Handicapped, Research Reviews (Publications), Visually Handicapped
Reviewed was research on the development of the cognitive skills of language, concept formation, and arithmetic in children handicapped by blindness, mental retardation, or deafness. Research on the language skills of the blind included a rejection of sensory compensation, while research on language in the retarded was seen to focus on linguistic variables and reading ability. Included among the research on language development of the deaf was research which was reported to suggest the value of early sign language training for cognitive development and the author's research on written language comprehension by the deaf. Research on concept formation in the blind found deficiencies in concept formation among the blind, while concept problems in the retarded were found to be in the areas of language control and verbalization rather than perception. Research on concept development in the deaf showed conflicting findings on whether a concept deficiency exists once verbal aspects are removed. Little research on arithmetic skills in the blind was reported, but one finding of skill development in the retarded showed better computation skills than normal children of the same mental age. The author's research found that the mathematical performance of deaf children was usually slightly higher than that of normal hearing children. (DB)

**ED 074 154** TM 002 519
*Knipe, Walter H.* *Krahmer, Edward F.*
**An Application of Criterion Referenced Testing.**
Pub Date 27 Feb 73
Note—19p.; Paper presented at annual meeting of the American Educational Research Association (New Orleans, Louisiana, February 25-March 1, 1973)
**EDRS Price MF-$0.65 HC-$3.29**
Descriptors—Computer Assisted Instruction, *Criterion Referenced Tests, Elementary Grades, *Mathematics Instruction, *Performance Contracts, *Program Evaluation, Speeches, Teacher Attitudes, Technical Reports, Testing Programs
Criterion referenced testing has received considerable theoretical, but only limited practical, application. Grand Forks School District has developed mathematics criterion referenced tests for grades three to nine. The tests are keyed to a hierarchical set of approximately 50 performance objectives and 40 individualized contracts per grade level. These tests were administered on a pre-post basis during 1971-72. This study was designed to consider the following three concerns: (1) adoption experiences when using criterion referenced testing, (2) research conclusions as a byproduct of this testing, and (3) attitudes of classroom teachers to this method as compared to nationally formed tests. Data for the second concern indicate different orders and grade levels at which students learn specific skills in various schools. (Author)

**ED 073 553** 24 EA 004 943
**Course Goals in Mathematics, Grades K-12. Critique Draft.**
Multnomah County Intermediate Education District, Portland, Oreg.
Spons Agency—National Center for Educational Research and Development (DHEW/OE), Washington, D.C. Regional Research Program.; Oregon State Board of Education, Salem.
Bureau No—BR-2-J-032
Pub Date 72
Contract—OEC-X-72-0026(257)
Note—184p.; Tri-County Goal Development Project
Available from—Hard copy is not available
**EDRS Price MF-$0.65 HC Not Available from EDRS.**
Descriptors—Course Content, *Course Objectives, *Curriculum Development, Development, Educational Accountability, Educational Objectives, *Mathematics, *Mathematics Curriculum, *Mathematics Education, Public Schools
This document is one part of a critique series that deals with the development and evaluation of course goals in six subject matter areas for grades K-12. The series provides an initial pool of course-level goals that are expected to be of considerable value in assisting educators with goal definition related to curriculum planning and development, instruction, evaluation, and accountability. Goals for the mathematics curriculum are organized according to a subject matter taxonomy. Number systems goals are divided into goals for whole numbers, integers, rational numbers, real numbers, complex numbers, matrices and determinants, vectors, and algebraic expressions. Goals for numeration, mathematical sentences and their solutions, relations and functions, geometry, measurement, sets, logic, probability and statistics, history of mathematics, and use of computational devices are also presented. Four sets of indexes offer the possibility of retrieving course goals by subject matter, knowledge and process, subject area, and career education. Related documents are EA 004 941-2, EA 004 943-948, and ED 061 043. (Author/DN)

Math Education—Volume 5, Number 3, 1973
1250—RF-2228

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**Investigations in Mathematics Education**

The list of subscribers to **Investigations in Mathematics Education** is continuing to grow. In the journal are abstracts and analyses of recent research reports in mathematics education. For further information about subscriptions to **Investigations in Mathematics Education,** write:

Jon L. Higgins, Editor
**Investigations in Mathematics Education**
Center for Science and Mathematics Education
The Ohio State University
1945 North High Street
Columbus, Ohio 43210

Incidentally, some printing problems delayed the publication of Volume 6, Number 2; subscribers should receive their copies soon. Volume 6, Number 3 is now at the printers.

## Oops!

In the last issue of this Newsletter (Vol. 5, No. 2), two errors have been found in the review of "Research on Elementary School Mathematics, 1972." First, on page 1, Weaver (1972) reported data from 23 **schools**: that means 135 classes, instead of the 23 stated. And on page 2 is a similar error: in Kratzer's (1972) study a total of 12 classes were involved. Apologies are offered for the inadvertent diminishing of the scope of these studies—and thanks go to the two authors for calling attention to the erroneous information.

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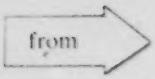


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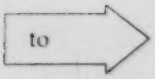


. . . fact sheets and bulletins designed to meet specific needs

This issue ends the series of ERIC/SMEAC Mathematics Education Newsletters. This is the result of a policy decision by Central ERIC, stating that clearinghouses will no longer publish newsletters on a regular basis.

Instead, we'll be producing publications that are directed to a specific audience. These will include fact sheets and special bulletins to be published from time to time, dealing with a variety of topics of particular interest to specific groups.

Because of this change, we need your help in forming new mailing lists. A mailing request form can be found on page 3 of this newsletter. Please be sure to fill out and return the form: it's essential if you want to continue to receive any ERIC/SMEAC publications.

We have been discussing some potential topics for the fact sheets and bulletins to be published during this year. We've tentatively defined the following so far:

. . . **A Metric Handbook for Teachers**
This will contain specific suggestions for a sequential development of measurement ideas, leading to integrated teaching of the metric system.

. . . **Mathematics Laboratories: Some Suggested Activities**
This will indicate some of the materials collected in the project on mathematics laboratories which has been underway here at ERIC/SMEAC.

. . . **Research on Elementary and Secondary School Mathematics, 1973: Reviews of Applicable Findings**
These will present a summary of research findings which answer questions which classroom teachers as well as researchers may have asked.

We welcome your suggestions for other topics: just drop a note to Jon Higgins or Marilyn Suydam, ERIC/SMEAC, 400 Lincoln Tower, The Ohio State University, Columbus, Ohio 43210. It will help us a great deal in planning to know what you perceive your information needs to be.

SE 017 936

**AERA Annual Meeting**

The 1974 Annual Meeting of the American Education Research Association will be held in Chicago during the week of April 15. The Special Interest Group for Research in Mathematics Education has reserved a suite for Monday and Tuesday: if you're at the meeting, please feel free to use the suite as an informal meeting place or just drop in for conversation. An informal hospitality hour will be held in the suite (which is in the Palmer House) immediately following the SIG/RME business meeting and invited address on Tuesday evening.

Attention is called to the following sessions dealing specifically with mathematics education. You will note that sessions have been scheduled to minimize conflicts with the NCTM meeting in Atlantic City.

Tuesday morning, 8:15-10:15 (Parlor A, Palmer House)

2.12 / BASIC AND INSTRUCTIONAL RESEARCH IN MATHEMATICS AND PROBLEM SOLVING (Critique, Division C)

Chairman: Thomas A. Romberg, Wisconsin Research and Development Center

Participants: Richard E. Mayer, Indiana University
George F. Luger, University of Pennsylvania
Terry M. Wildman and Harold J. Fletcher, Florida State University
Terrill A. Mast and Emanual J. Mason, University of Kentucky
George R. Ross, Jr. and Harold J. Fletcher, Florida State University
William L. Gaslin, Minneapolis Public Schools
A. Edward Uprichard and Carolyn Collura, University of South Florida

Critic: Guy J. Groen, Research Consultant

Tuesday morning, 8:45-10:15 (PDR #18, Palmer House)

3.08 / THE DEVELOPMENT OF LOGICAL ABILITIES (Symposium, Division B)

Chairman: Lars C. Jansson, University of Manitoba

Participants: Jerry R. Shipman, Alabama A & M University
Laurence I. Tripp, New Milford High School
Lars C. Jansson, University of Manitoba
Thomas C. O'Brien, Southern Illinois University

Discussant: P. C. Wason, England

Tuesday afternoon, 12:25-1:55 (Directors, LaSalle Hotel)

5.06 / MATHEMATICAL LEARNING: WHAT RESEARCH SAYS ABOUT SEX DIFFERENCES (Symposium, SIG/Research on Women and Education and SIG/Research in Mathematics Education)

Chairwoman: Jenny R. Armstrong, University of Wisconsin-Madison

Participants: Carol Nagy Jacklin and Eleanor Maccoby, Stanford University
Lewis Aiken, Guilford College
Elizabeth Fennema, University of Wisconsin-Madison
Lynn H. Fox, Johns Hopkins University

Discussant: Marilyn N. Suydam, The Ohio State University

Tuesday afternoon, 4:05-6:05 (Crystal, Palmer House)

7.20 / SIG/RME BUSINESS MEETING AND INVITED ADDRESS (SIG/Research in Mathematics Education)

Chairman: F. Joe Crosswhite, The Ohio State University

Speaker: M. D. Merrill, Brigham Young University

Wednesday morning, 8:45-10:15 (Lincoln, LaSalle Hotel)

10.02 / METHODS OF INVESTIGATING THE LEARNING OF ABSTRACT STRUCTURES (Symposium, SIG/Research in Mathematics Education)

Chairman: Nicholas Branca, Pennsylvania State University

Participants: Nicholas Branca, Pennsylvania State University
Richard J. Shavelson, University of California, Los Angeles
William E. Geesling, University of New Hampshire
George Stanton, Stanford University

Discussants: Edward G. Begle, Stanford University
Merle Wittrock, University of California, Los Angeles

Wednesday morning, 10:30-12:05 (Crystal, Palmer House)

11.09 / MATHEMATICS LEARNING IN HANDICAPPED LEARNERS (Symposium, SIG/Special Education Research)

Chairwoman: Jenny R. Armstrong, University of Wisconsin-Madison

Participants: Thomas Romberg, University of Wisconsin-Madison
Clifford B. Gillman, University of Wisconsin-Madison
Roger A. Severson and Tom Kratochwill, Psychoeducational Clinic, Madison, Wisconsin
Jenny R. Armstrong, University of Wisconsin-Madison

Thursday morning, 8:45-10:15 (PDR #8, Palmer House)

18.05 / STRUCTURAL VARIABLES THAT ACCOUNT FOR THE DIFFICULTY LEVEL OF EXERCISES IN MATHEMATICS (Symposium, Division C)

Chairman: Max E. Jerman, Seattle Pacific College

Participants: Edward C. Beardslee and Max E. Jerman, Seattle Pacific College
Lars C. Jansson, University of Manitoba
Jeffry C. Barnett, Pennsylvania State University and Max E. Jerman, Seattle Pacific College
Blair C. Cook, Pennsylvania State University

Discussant: L. Ray Carry, University of Texas

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**Computer Searches**

Computer searches using the ERIC files are available from Indiana University (in addition to those cited in the last newsletter). The name of the Indiana system is PROBE. PROBE is a flexible program, able to furnish the user with a variety of requests, including an abstract search.

For further information, write: Robert Benninghoff, PROBE Director, Room 30, Education Building, Indiana University, Bloomington, Indiana 47401.

**NSF Conference Reports**

Reports on three of the conferences sponsored by the National Science Foundation during the summer of 1973 have been processed for the ERIC system. One of the reports is currently available: "Report of the Conference on the K-12 Mathematics Curriculum, Snowmass, Colorado, June 21-June 24, 1973." It may be ordered from the ERIC Document Reproduction Service, $0.65 for microfiche copy and $3.29 for hard (paper) copy. Please specify the document number, ED 081 643.

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**Please!**

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400 Lincoln Tower
The Ohio State University
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The ERIC Information Analysis Center for Science, Mathematics, and Environmental Education will produce fact sheets and bulletins for various interest groups.

If you would like to be placed on the mailing list, please complete and return this coupon.

1. Please indicate **not more than two** areas of interest:
   - ____ Elementary school mathematics
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**NCTM Annual Meeting**

The 52nd Annual Meeting of the National Council of Teachers of Mathematics will be held in Atlantic City from April 17 to 20. The program has something to offer mathematics teachers at every level from kindergarten through college. There will be workshops, swap sessions, and small and large sessions on many topics. This newsletter is too short to list all of the sessions: consult an NCTM program for that! Following is a list of some of the section meetings which might be of special interest to researchers.

RESEARCH REPORTING SESSIONS are scheduled for:

Thursday, April 18 at 10:30 and at 1:30
Friday, April 19 at 9:00, 10:30, 1:30, and 4:30
Saturday, April 20 at 10:30

Thursday morning, 10:30-1:00 (Walnut Room-L)

No. 38: LEARNING STYLES AND MANIPULATIVE INSTRUCTION ACTIVITIES (Teacher Education Section)

Moderator: Alan Osborne, The Ohio State University

Panel: Boyd Holtan, West Virginia University
Edward Moran, West Virginia State Department of Education
Neale Blackwood, Morris Harvey College
Ralph Hall, Marshall University

Thursday morning, 10:30-11:30 (West Room-H)

No. 40: NATIONAL ASSESSMENT: THE WHO, WHAT, WHERE, AND HOW OF THE MATHEMATICS ASSESSMENT (General Interest Section)

Presider: Aaron L. Buchman, State Department of Education, New York

Speakers: Wayne H. Martin, National Assessment of Educational Progress, Denver
Teresa Salazar, National Assessment of Educational Progress, Denver
Robert E. Reys, University of Missouri

Thursday afternoon, 12:00-1:00 (Pennsylvania Room B-S)

No. 68: A PROGRAM OF RESEARCH IN MATHEMATICS EDUCATION (Research Section)

Presider: Margaret J. Cotter, Dwight Morrow High School, Englewood, New Jersey

Speaker: E. G. Begle, Stanford University

Thursday afternoon, 3:00-4:00 (Pennsylvania Room B-S)

No. 112: A SYMPOSIUM: THE LEARNING OF MATHEMATICAL GROUP STRUCTURES

Speakers: Nicholas A. Branca, The Pennsylvania State University
Roger J. Chilewski, Saint Xavier College, Chicago
Howard M. Kellogg, Brooklyn College

Discussant: J. Fred Weaver, The University of Wisconsin-Madison

Friday afternoon, 12:00-1:00 (Gold Room-S)

No. 206: SCHOOL MATHEMATICS INSTRUCTION AND THE ELECTRONIC CALCULATOR: WHAT SHOULD BE INVESTIGATED? (Research Section)

Leaders: J. Fred Weaver, The University of Wisconsin-Madison
Thomas A. Romberg, The University of Wisconsin-Madison

Friday afternoon, 3:00-4:00 (Gold Room-S)

No. 263: PROVIDING FOR RESEARCH AND EVALUATION IN CURRICULUM PROPOSALS (Research Section)

Presider: James W. Wilson, University of Georgia

Speaker: Earl M. L. Beard, University of Maine

Saturday morning, 9:00-10:00 (Pennsylvania Room B-S)

No. 306: A SYMPOSIUM: THE GROWTH OF RESEARCH IN MATHEMATICS EDUCATION (Research Section)

Leaders: Jon L. Higgins, The Ohio State University
Marilyn N. Suydam, The Ohio State University

# CENTER CLIPPINGS...

These documents are some of those announced in **Research in Education** during October, November, or December 1973.

**ED 080 384** SE 016 668

*Kilpatrick, Jeremy, Ed. Wirszup, Izaak, Ed.*

**Soviet Studies in the Psychology of Learning and Teaching Mathematics, Volume 6, Instruction in Problem Solving.**

Chicago Univ., Ill., Stanford Univ., Calif. School Mathematics Study Group.

Spons Agency—National Science Foundation, Washington, D.C.

Pub Date 72

Note—136p.

Available from—A. C. Vroman, Inc., 2085 East Foothill Blvd., Pasadena, Calif. 91109

**Document Not Available from EDRS.**

Descriptors—Concept Formation, Educational Psychology, *Instruction, Learning, Mathematical Vocabulary, *Mathematics Education, *Problem Solving, *Research, Thought Processes

Identifiers—Research Reports, Russia

The series is a collection of translations from the Soviet literature of the past 25 years on research in the psychology of mathematical instruction and the related methods of teaching mathematics. The aim of the series is to acquaint educators and teachers with directions, ideas, and accomplishments in the psychology of mathematical instruction in the Soviet Union. This volume contains nine articles concerned with instruction in problem solving. Some topics covered extensively are the formation of the concept of "type of problem," the influence of vocabulary, a suggested analytic-synthetic method for use at every grade level, and whether or not to use algebraic methods in the elementary grades. Related documents are ED 042 628, ED 042 632, ED 042 633, SE 016 666, and SE 016 667. (LS)

**ED 079 157** SE 016 545

*Warpinski, Robert*

**A Supplementary Program for Environmental Education, Mathematics, Grade 5-6.**

Project I-C-E, Green Bay, Wis.

Spons Agency—Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.

Pub Date 72

Note—75p.

**EDRS Price MF-$0.65 HC-$3.29**

Descriptors—Behavioral Objectives, *Elementary Grades, *Environmental Education, Fundamental Concepts, Grade 5, Grade 6, Instructional Materials, Interdisciplinary Approach, Learning Activities, *Lesson Plans, *Mathematics, *Teaching Guides

Identifiers—ESEA Title III

Presented in these teacher's guides for grades five and six are lesson plans and ideas for integrating mathematics and environmental education. Each lesson originates with a fundamental concept pertaining to the environment and states, in addition, its discipline area, subject area, and problem orientation. Following this, behavioral objectives and suggested learning experiences are outlined. Behavioral objectives include cognitive and affective objectives and skills to be learned, while learning experiences list student-centered in-class activities and outside resource and community activities. Space is provided for teachers to note resource and reference materials--publications, audio-visual aids, and community resources. The guides are supplementary in nature and the lessons or episodes are designed to be placed in existing course content at appropriate times. This work was prepared under an ESEA Title III contract for Project I-C-E (Instruction-Curriculum-Environment). (BL)

**ED 079 115** SE 016 447

**Mathematics 7-8 Handbook, 1973 Reprint.**

New York State Education Dept., Albany. Bureau of Secondary Curriculum Development.

Pub Date 69

Note—209p.

**EDRS Price MF-$0.65 HC-$9.87**

Descriptors—*Curriculum, Curriculum Guides, Grade 7, Grade 8, *Instruction, Mathematical Enrichment, Mathematics Education, *Secondary School Mathematics, *Teaching Guides

This handbook provides suggestions for teaching topics in seventh and eighth grade mathematics and was intended to be used as a supplement to the seventh and eighth grade syllabus (see SE 016 446). Optimal materials, activities, and approaches are suggested for the following topics: sets; numeration systems; natural numbers, whole numbers, rational numbers, integers, and real numbers; ratio, proportion, percent, and variation; geometry; statistics; and probability. (DT)

**ED 077 767** SE 016 404

*Pigge, Fred L. And Others*

**Final Evaluation Report, Exemplary Middle School Mathematics.**

Bowling Green State Univ., Ohio. Office of Educational Research and Services., Galion School System, Ohio.

Spons Agency—Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.

Pub Date Aug 72

Note—261p.

**EDRS Price MF-$0.65 HC-$9.87**

Descriptors—*Curriculum, Evaluation, *Individualized Instruction, *Instruction, Mathematics Education, Middle Schools, Program Descriptions, *Research, *Secondary School Mathematics

Identifiers—ESEA Title III

The second year of a project to test whether student achievement in mathematics could be increased through restructuring the learning environment was evaluated. Seventh graders were randomly divided into classes receiving one of three instructional methods, all emphasizing individualized instruction: a team-teaching approach; a self-contained, one-teacher approach; and a technological approach using one teacher, one teacher aide, and programmed materials with 30 teaching machines (Didactors). The Stanford Arithmetic Achievement Test was used as a pretest and posttest. Results showed that the mean of the self-contained classes was significantly higher than the means of the team-teaching and the Didactor groups on arithmetic computations, concepts, and applications. The cost-benefit ratio of the self-contained classrooms was more positive than were similar ratios for the other two groups. There were no significant differences in pupil attitude toward arithmetic under any of the three approaches. This document also contains a list of behavioral objectives for the program, teachers' comments on instructional methods used, and observer reports. This work was prepared under an ESEA Title III contract. (DT)

**ED 080 328** SE 016 406

*Underwood, Evelyn, Ed. And Others*

**Drop-In Mathematics.**

Arkansas State Dept. of Education, Little Rock.

Spons Agency—Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.

Pub Date 72

Note—264p.

**EDRS Price MF-$0.65 HC-$9.87**

Descriptors—Curriculum, *Grade 9, Instruction, *Instructional Materials, Mathematical Applications, Mathematics Education, Measurement, Number Concepts, Number Systems, *Secondary School Mathematics, *Workbooks

Identifiers—*General Mathematics

This material, organized in a workbook format, was developed to be used with the non-college bound, lower one-third of the ninth-grade student population. Topics covered are flowcharts, set theory, number systems (natural numbers, whole numbers, integers, and rationals), number operations, percentage, measurement, finance, geometric constructions, statistics, and number bases. For the teacher's manual, see SE 016 407. (DT)

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**Evaluation and Tests: Two Publications**

Two new ERIC/SMEAC publications are available from The Center for Science and Mathematics Education, 244 Arps Hall, The Ohio State University, Columbus, Ohio 43210.

- **Unpublished Instruments for Evaluation in Mathematics Education: An Annotated Listing.** Marilyn N. Suydam. 264 pages, $2.75.

  Non-commercial investigator-developed tests and other instruments to assess mathematical instruction, reported in journals and dissertations from 1964 through 1973, are listed. For approximately 200 instruments, information on content, format, sample, reliability, correlations, and validity is included, as well as references. Other instruments for which only partial information was available are also cited on a supplementary list. (No instruments are included.)

- **Evaluation in the Mathematics Classroom: From What and Why to How and Where.** Marilyn N. Suydam. 70 pages, $1.75.

  This document discusses the role and the scope of evaluation in the mathematics classroom. The scope of mathematics objectives to be evaluated, the scope of evaluation purposes in the classroom, and the scope of evaluation procedures are noted. Specific comments are made on various procedures: observations, interviews, inventories and checklists, attitude scales, and various types of paper-and-pencil tests. Both general and specific suggestions for planning tests and for writing various types of test items are given. An annotated list of selected references is included to direct attention to documents which will provide additional help.

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